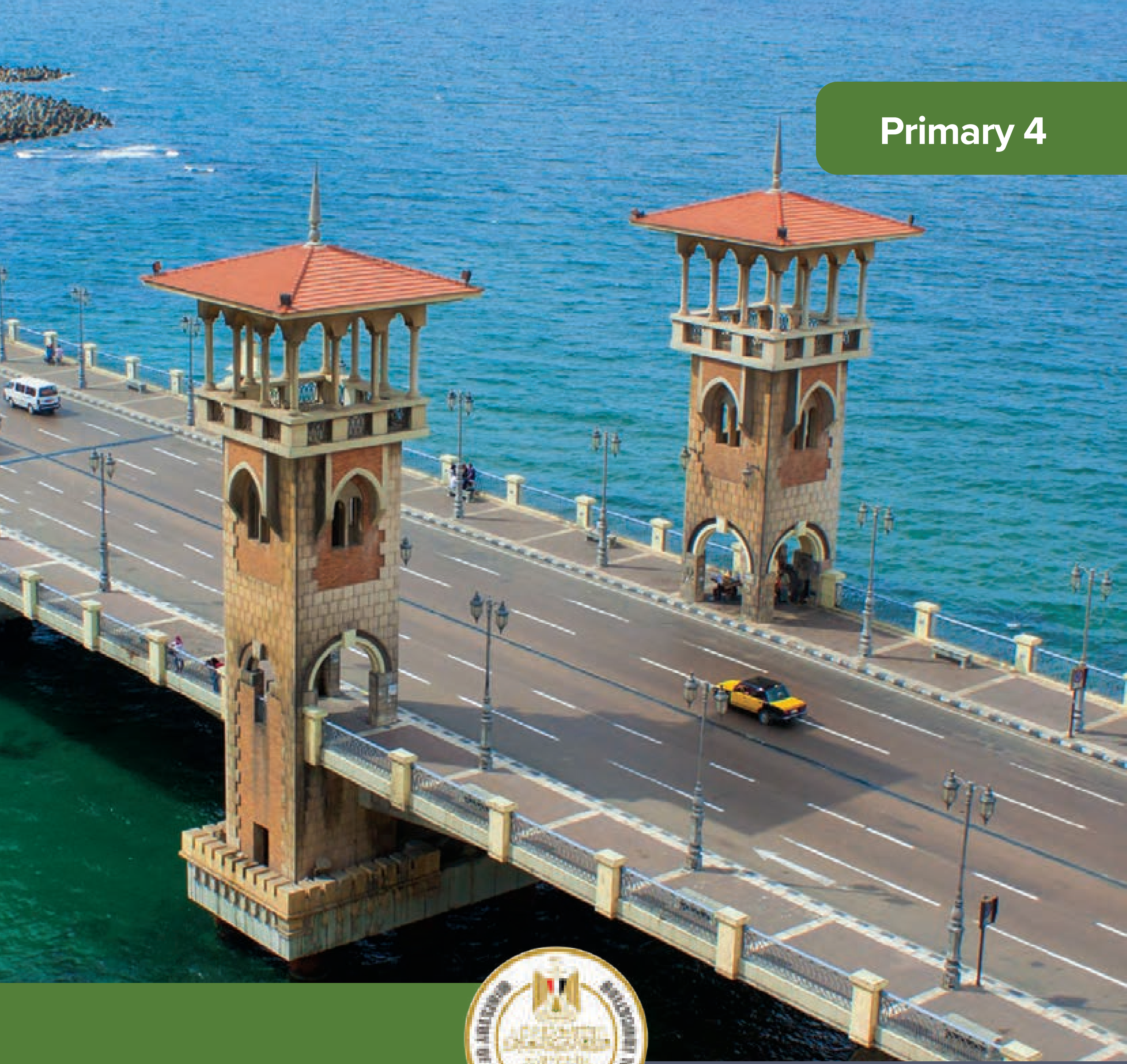
Primary 4



Science Term 1

Primary 4 Science

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Reviewed by

The General Administration for Planning and Formulating Curriculum

Supervised by

Dr. Akram Hassan

Head of the Central Administration for the development of Curricula

FOREWORD

The MOETE launched Egypt's reform vision for the development of education, and the process of developing curricula comes at the heart of this vision. The implementation of this vision was heralded in 2018, starting with the kindergarten stage in its first and second grades, with the aim of continuing until the end of the secondary stage.

This vision endeavored to make major transformations in the teaching and learning processes, where there is a transition from acquiring knowledge to producing it, and from learning skills to employing them both in specific learning situations and in the general life of the learner outside the classroom. Our curricula also integrate values that contribute to the establishment of our society—values which pose as a protective fort for our homeland. Egypt's reform vision for curriculum development also aims to take into account the specifications of pre-university education graduates, as well as the challenges Egypt faces locally, regionally, and globally. The developed curricula are intended to foster a citizen who is capable of engaging in civilized conversations and positive dialogues with the other, in addition to acquiring digital citizenship skills.

In this regard, the MOETE extends its gratitude and appreciation to the Central Administration for the Development of Curricula and Educational Materials. It also extends its thanks and gratitude to Discovery Education for their active participation in the preparation of this book. Gratefulness also goes to all the Ministry's experts who contributed to the enrichment of this work.

This transformation of Egypt's education system would not have been possible without the significant support of Egypt's current president, His Excellency President Abdel Fattah el-Sisi. Overhauling the education system is part of the President's vision of "rebuilding the Egyptian citizen" and it is closely coordinated with the Ministries of Higher Education and Scientific Research, Culture, and Youth and Sports. The new education system is only a part in a bigger national effort to propel Egypt to the ranks of developed countries, and to ensure a great future for all of its citizens.

WORDS FROM THE MINISTER OF EDUCATION & TECHNICAL EDUCATION

Dear students and fellow teachers,

It gives me great pleasure to celebrate this crucial stage of comprehensive and sustainable development, an epic in which all Egyptian people are taking part. This pivotal stage necessitates paving a foundation for a strong educational system which yields a generation that is not only capable of facing the major challenges the world is witnessing today, but one that also has complete possession of the skills of the future. For this reason, the Egyptian state is keen on empowering its citizens by establishing a top-notch educational system that invests in its children the expertise required to get them to compete at both a regional and global level, at a time when the world is witnessing successive industrial revolutions.

This dictates that our educational system has at its core an emphasis on skills development, deep understanding, and knowledge production. This can only be done through modern curricula that keep up with the changes taking place globally-- curricula which prioritize the development of skills and values, and the integration of knowledge. They are also curricula that focus on the provision of multiple learning sources, and integration of technology to enrich the educational process and to improve its outcomes, while addressing the most important contemporary issues.

To achieve this, we must all join hands to continue to revolutionize our education, and to support it with all that is required to transform it into a globally pioneering educational system.

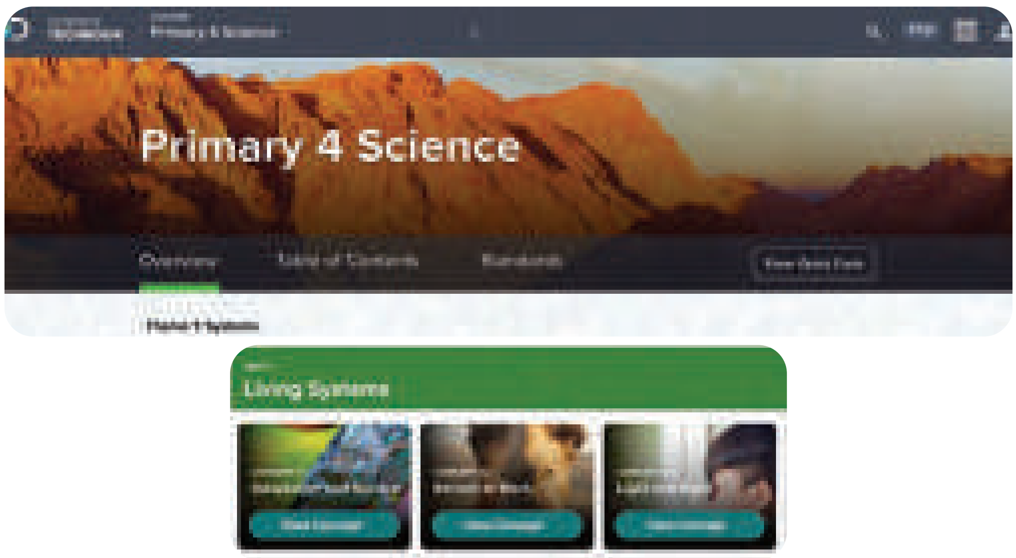
My warmest regards to you, dear students, and my deepest gratitude to my fellow teachers.

Professor Reda Hegazy

Minister of Education and Technical Education

Dear Parent/Guardian,

This year, your student will be using Science Techbook™, a comprehensive science program developed to inspire students to act and think like scientists and engineers. Throughout the year, students will ask questions about the world around them and solve real-world problems through the application of critical thinking across the domains of science (Life Science, Earth and Space Science, Physical Science, Environmental Science, and Engineering).



Science Techbook is an innovative program that helps your student master key scientific concepts. Students engage with interactive science materials to analyze and interpret data, think critically, solve problems, and make connections across science disciplines. Science Techbook includes dynamic content, videos, digital tools, hands-on investigations and labs, and game-like activities that inspire and motivate scientific learning and curiosity.

Science Techbook is divided into units, and each unit is divided into concepts. Each concept has three sections: Wonder, Learn, and Share.

Units and Concepts Students begin to consider the connections across fields of science to understand, analyze, and describe real-world phenomena.

Wonder Students activate their curiosity and prior knowledge of a concept's essential ideas and begin making connections to a real-world situation.

Learn Students dive deeper into core scientific concepts through critical reading of texts and analysis of multimedia resources. Students also build their learning through investigations and interactives focused on the learning goals.

Share Students share what they are learning with their teacher and classmates using evidence they have gathered and analyzed during Learn. Students connect their learning with entrepreneurship, careers, and problem-solving skills.

Within this Student Edition, you will find QR codes and quick codes that take you and your student to a corresponding section of Science Techbook online.

We encourage you to support your student in using the print and online interactive materials in Science Techbook, on any device. Together, may you and your student enjoy a fantastic year of science and exploration.



Sincerely,

The Science Team

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Theme 1 | Systems

Unit 1
Living Systems

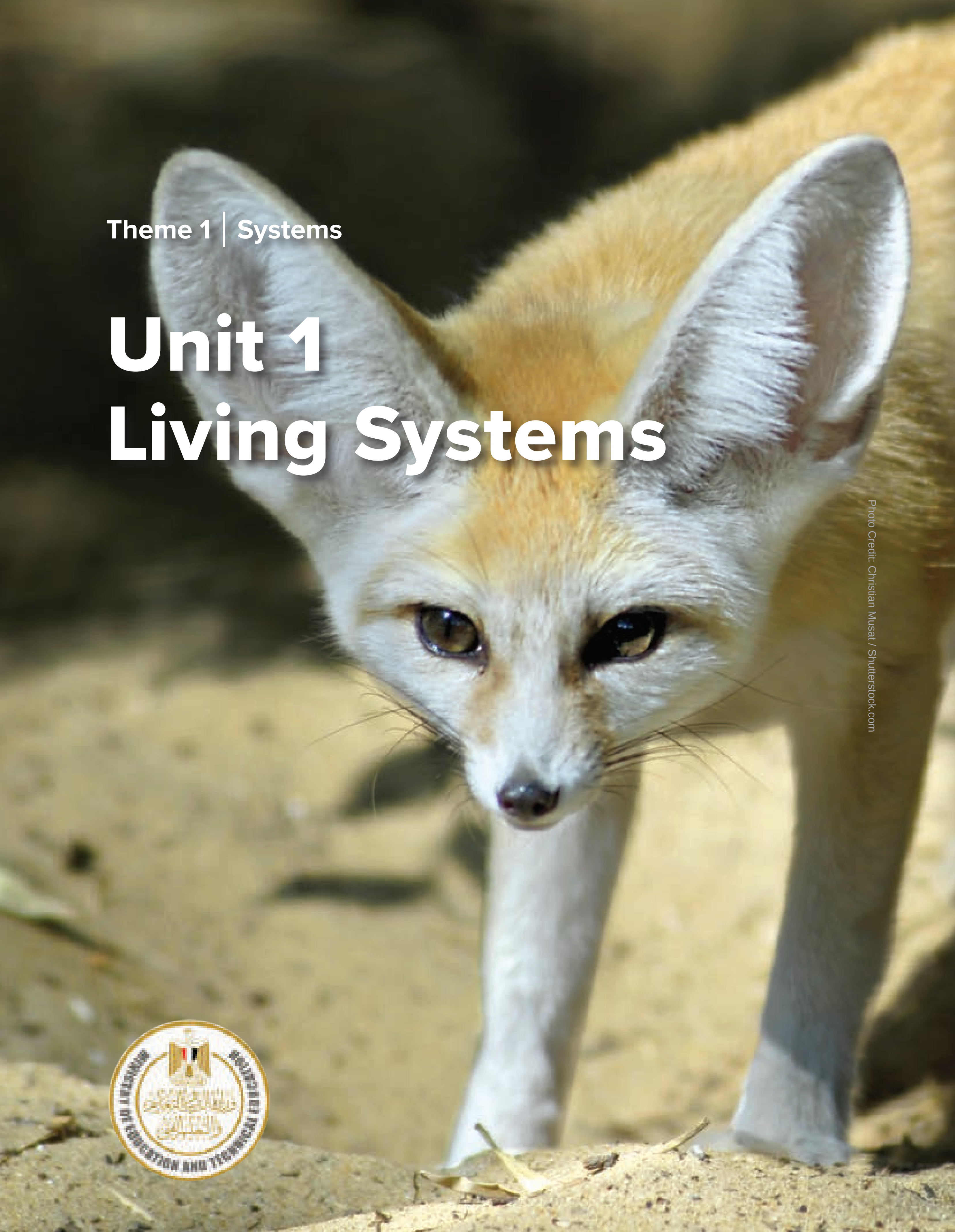


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What I Already Know

Hot and cold temperatures, too much or too little water, availability of food or shelter—these issues can make survival difficult for living organisms. Over time, animals and plants adapt or change so that they can live, eat, breathe, stay safe, and so on. Think about the familiar animals and plants pictured here.







What are some ways these living organisms have adapted to environmental conditions? Why did the animal or plant adapt or change?

Talk Together What about humans? Can you think of ways that people change how they act or dress because of their environments?

During this unit, you will learn a lot more about how living organisms adapt and change. You will investigate how humans and animals use senses to gather information and navigate or get around. You will study a specific adaptation that has to do with the senses of sight and sound—animals that are nocturnal, meaning they are most active at night. Finally, you are going to connect all of your learning about adaptations to determine how animals communicate and transfer information.

Studying Bats



You might think bats, such as those pictured on this page, are scary. Actually, bats are pretty important to both humans and other living organisms. Scientists often think about a particular animal as part of a larger community of living organisms. As you learn more about adaptations and living systems, you will be asked to think about how bats (and other animals) play specific roles in an ecosystem, and you might find that they are not scary at all.



A bat flying

Did you know that bats have a structure that allows them to fly like birds? Did you know that many bats eat mosquitoes and other insects? Did you know that bats can help plants and flowers similar to bees and butterflies? Did you know that bats are nocturnal, which means they are most active at night? Did you know that even bats that cannot see well at night can navigate using a very cool adaptation called echolocation?

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Solve Problems Like a Scientist

Unit Project: Bat Chat

In this project, you will research bats to learn how their adaptations help them navigate and communicate.

Ask Questions About the Problem

You are going to create a diagram that models how bats use sound to avoid obstacles and find prey. **Write** some questions you can ask to learn more about the problem. As you learn about adaptations and senses in this unit, **write** down the answers to your questions.



Life Skills **I can use information to solve a problem.**

CONCEPT 1.1

Adaptation and Survival

Student Objectives

By the end of this concept:

- [ ] I can model the relationships between an organism's survival, habitat, adaptations, and body systems.
- [ ] I can argue from evidence that plants and animals have structures and behaviors that help them survive and grow.
- [ ] I can explain how structural adaptations help organisms survive in specific environments.
- [ ] I can argue from evidence that multiple adaptations or organs work together in systems to help organisms survive in specific habitats.

Key Vocabulary

- [ ] adaptation
- [ ] camouflage
- [ ] digestive system
- [ ] ecosystem
- [ ] energy
- [ ] extinct
- [ ] organism
- [ ] pollute
- [ ] predator
- [ ] prey
- [ ] reproduce
- [ ] respiratory system
- [ ] survive
- [ ] organs

Activity 1

Can You Explain?



Have you ever seen a desert lizard like this one? This starred agama keeps cool by finding shade during a hot sunny day. Many animals have special ways to keep cool in the hot desert. How do different types of animals adapt to hot, dry climates?

How do different types of animals and plants adapt to survive extreme climates?

Life Skills **I can share ideas I am not yet sure about.**

Activity 2

Ask Questions Like a Scientist

Penguin

Climate is one reason many organisms adapt over generations. An animal you may not know a lot about is the penguin. Penguins in Antarctica live in a polar climate that is one of the coldest places on Earth. **Use** the text, then, **answer** the questions that follow.

Have you ever held ice in your hand? How long do you think you could stand on a sheet of ice in bare feet? You would lose feeling in your toes after only two minutes. Amazingly, a penguin has no feathers on its feet, but it can stand around on ice all day. This is important because, unlike most birds, penguins cannot fly. So why don't a penguin's feet freeze?



In addition to other features, such as dense feathers and a thick layer of fat, the way blood moves through a penguin's feet keeps their entire body warm. Blood vessels bring cold blood up from the feet. Other blood vessels bring warm blood down to the feet from the feather-coated body. These vessels weave around each other. Where they touch, the warm blood vessels can then heat up the cold blood vessels. This means the blood traveling up into the body is not cold, and blood flowing down to the toes is warm enough to keep their toes from freezing.

Your Ideas

How do penguins' feet help them survive in cold climates? and give other example of animals that live in different cold environment.

Talk Together The big ears on a fennec fox help it stay cool. The path of blood vessels in a penguin help its feet stay warm. How are these adaptations similar? How are they different?

Life Skills **I can ask questions to clarify.**

Activity 3

Observe Like a Scientist

Adaptations for Survival

Scientists ask a lot of questions. When scientists learn something new, new questions come to mind. **Read** the text about another type of adaptation that helps animals survive. Then, **write** two questions you have.

Adaptations for Survival



Adaptations are characteristics that help living organisms survive and **reproduce** in the **ecosystem** in which they live. For example, thick, white fur is an adaptation in polar bears. It helps them stay warm in their cold, Arctic home. It also helps polar bears blend in with the snow as they sneak up on their prey.

In contrast, many bears that live in other habitats have darker fur. Brown bears and black bears live in forests. Their dark fur helps them stay hidden among the trees as they hunt. Sandy-colored fur helps desert animals, such as caracals and fennec foxes, blend in with desert landscapes. Rocks in the desert can also be quite colorful. Many lizards have colorful scales that make them hard to see among the rocks. This type of adaptation that hides animals from a **predator** or their **prey** is called **camouflage**.

Can the fur on some animals change color with different seasons? What prey do polar bears need to sneak up on? **Write** other questions.

I wonder . . .

Activity 4

Analyze Like a Scientist

Types of Adaptations

Animals can be found from the coldest polar regions to the hottest deserts and the deepest oceans on our planet. An adaptation is a characteristic of an animal that helps the animal survive. An adaptation can be structural, a change to the animal's body, or behavioral, a change to the way a group of animals behaves or acts.

Read the text that follows, think about both the structural and behavioral adaptations described. **Circle** behavioral adaptations and **underline** the structural adaptations you find in the passages.



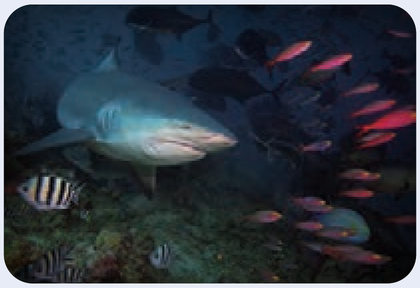
Fennec foxes and Arctic foxes both live in extreme climates. Fennec foxes have a tan-colored coat that provides camouflage in a sandy, rocky environment and protects them from the scorching hot sun. Fennec foxes, like dogs, also cool themselves by panting, taking up to 700 breaths per minute. Arctic foxes live in a different type of desert, a tundra. With temperatures as cold as 50 degree below zero (50º).C in the winter months, a thick fur coat helps them hunt even in deep snow. This coat is white during the winter but turns brown in summer when the snow melts, so they can sneak up on prey in any season. Extra-large ears allow heat to escape to cool fennec foxes, while short ears and legs help the Arctic fox stay warm. Both types of foxes also live in burrows. A burrow is an excellent place for the Arctic fox to stay warm at night and the fennec fox to stay cool during the day. Food can be hard to find at times in both the hot, dry desert and the cold tundra. Both foxes have learned to eat all kinds of food, including insects, fruit, plant roots, and even leftovers from another animal's prey.

Animals that are flexible about what they eat and where they hunt are well-adapted for survival. Bull sharks are special because they can **survive** in both salt water and fresh water, unlike other sharks. Since there are no other sharks in fresh water, bull sharks

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have less competition for finding food. They can also sneak up on prey using a camouflage strategy called countershading. Bull sharks have a dark back and white belly. An animal swimming above in the ocean may not see the shark in the shadows. To an animal swimming underneath the shark and looking up, the bull shark may blend in with the bright light of the sun. These sharks sometimes hunt in the day as well as the night, allowing them to surprise their prey.



You have learned about unique survival strategies in some amazing animals. Scientists often classify information as they learn to understand similarities, differences, and patterns. Use the table to **classify** the structural and behavioral adaptations of these three animals.

Animal	Structural Adaptations	Behavioral Adaptations
Fennec Fox		
Arctic Fox		
Bull Shark		

What Are Some Examples of Adaptations in Animals and Plants?

Activity 5

Observe Like a Scientist

The Panther Chameleon

The starred agama lizard you met earlier has adapted to survive in the very hot, dry desert. The panther chameleon is a lizard that lives in a very different environment: a tropical rainforest. Both lizards are reptiles. This means that their bodies are covered with scales. Reptiles are an ancient type of animal found around the world. Lizards in different environments have developed distinct adaptations.

Read the text that follows to learn more about the special adaptations of the panther chameleon.

The first thing you might notice about a panther chameleon is its brightly colored scales. Unlike the brown and yellow colors of the desert, the rainforest is filled with green leaves and colorful flowers in bloom. Multiple bright colors provide camouflage for the panther chameleon.



All day long, the chameleon is on the hunt. It holds tightly to branches and vines using V-shaped feet and a tail that can be used like a hand. The chameleon's eyes are especially helpful as it searches for insects. Can you look two different directions at the same time? Unlike human eyes, chameleon eyes face opposite directions and can move independently of each other. One eye can be searching for something to eat, while the other is on the lookout for danger in a totally different direction.

Life Skills **I can respect others' ideas.**

This adaptation This adaptation allows the panther chameleon to both find a meal and avoid becoming prey at the same time.

If the chameleon does find itself in danger, however, it has one last trick. Since this lizard does not have teeth or claws for defense, it tries to make itself look fierce. First, it puffs up its body with air. Then, it opens its mouth wide. It can also change the colors of its scales. This display will probably scare the attacker.

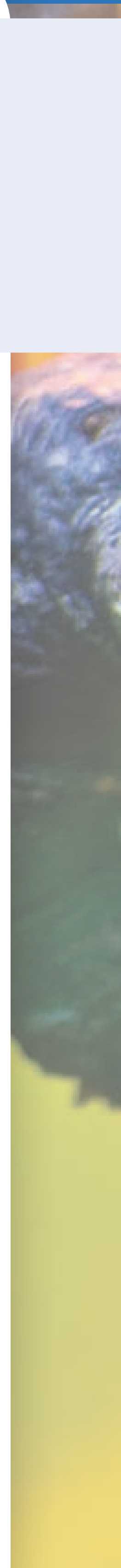


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How is the panther chameleon well-adapted for survival in the rainforest?
In the table, **record** the adaptations described in the passage. Then, **classify** each as structural or behavioral. **Describe** how each adaptation helps the chameleon survive.

Data Table: Evidence of Adaptations in Living organisms

Adaptation	Structural (S) or Behavioral (B)	How does the adaptation help the animal?

Activity 6

Analyze Like a Scientist

Plant Adaptations

You can find plants growing in almost every place that sunlight shines. Even the bottom of sea ice in polar regions has tiny plants growing on it. Like animals, plants have structural adaptations that help them survive and grow in different environments. Can plants also have behavioral adaptations? **Read** the passage that follows to find out.

Two Terrific Trees

Surviving on the Southern African savannah can be tough for many plants. The temperature in this grassland habitat is mild, but the lack of water is extreme. During the dry season, which lasts for half of the year, almost no rain falls. Due to these drought conditions, most large plants cannot grow there. If you stand on a hill and look over the savannah though, there is one large tree that can be seen scattered throughout the landscape.

This is an acacia tree. The acacia is able to survive through many months of drought. Tiny leaves growing on the top of this "umbrella" tree help hold in water while soaking up sunlight needed to make food. One very long root, a taproot, grows downward. This root searches for water as deep as 35 meters below the surface. Like a camel storing fat in its hump, the acacia tree stores water in its trunk.



Umbrella Acacia

Many plants in the savannah are eaten by animals for the water and nutrients they hold. Why is the acacia not one of them?

First, most animals (except the giraffe) cannot reach high enough to get a mouthful. Second, sharp spines guard the leaves from hungry mouths. When an animal begins eating the leaves of the acacia, the tree also begins to produce a poison that makes the leaves taste terrible. It then sends a smelly message in the wind to acacia trees nearby telling them to start making the same poison.

Across the Atlantic Ocean in the Amazon rainforest of Brazil, another umbrella-shaped tree rises above the landscape. In the overgrown rainforest, it is easy to find water but hard to reach sunlight. Growing up to 70 meters tall, the kapok emerges high above other trees. Above other treetops, leaves can get torn by the wind. Hand-shaped leaves with narrow parts allow wind to move more gently through the leaves. The kapok tree uses the wind to send a different type of message than the acacia tree. Instead of keeping animals away, the kapok invites bats to come visit its delicious-smelling flowers. The wind also carries the tree's fluffy yellow seeds across the forest.


Buttress Roots of the Kapok Tree

How does this extra tall tree stay upright in soggy soil? The kapok tree stays firmly rooted thanks to large, wide roots called buttress roots. Even though they are not planted deeply in the ground, the roots begin high up on its trunk, holding the tree securely in place. If you ever visit a rainforest, you can stand inside these roots—some of which can start up to 5 meters above ground.

Talk Together Did you read about any behavioral adaptations of the acacia or kapok trees? Do you think that plants can have behavior? Why or why not?

Activity 7

Think Like a Scientist

Plant Scientist

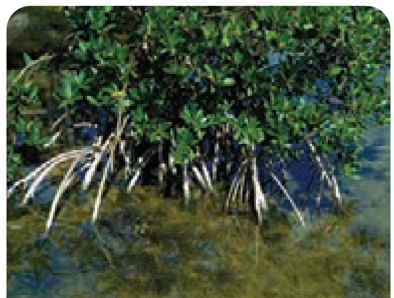
In this investigation, you will carry out the work of plant scientists, called botanists. You have just learned about how the roots, trunks, and leaves of two trees have adapted to extremely different environments. Consider what you know about how each part of a plant plays a role in getting the plant what it needs to survive.

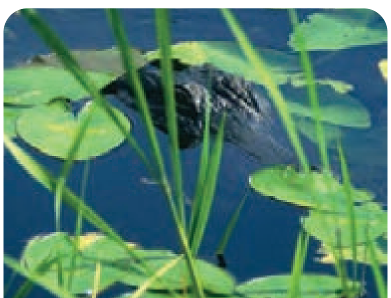
What Will You Do?

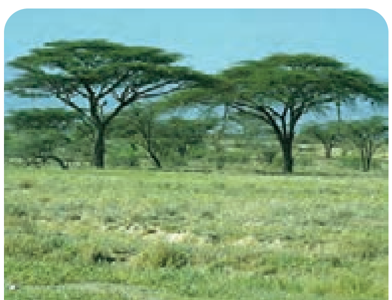
Examine the photos for clues that might tell a story about the conditions and environment where these plants live. Which adaptations do you think are critical to their survival? **Record** your answers in the table.

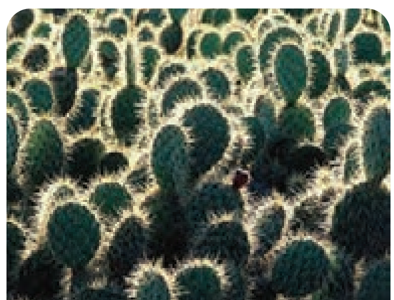

Palm Tree in a Desert


Pine Trees in the Snow


Mangrove Trees in Saltwater

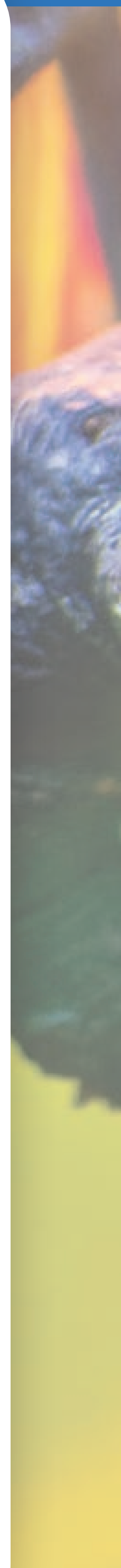

Water Lilies in a Wetland


Acacia Trees in the Savannah


Barbary Fig in a Desert

Life Skills **I can analyze a situation.**

Type of Plant	Structural adaptations I notice are . . .	I think this helps the plant to survive because . . .
Palm Tree	Thick trunk and narrow leaves	
Pine Tree	Triangle shape, needles instead of leaves	
Mangrove Tree		
Water Lily		
Acacia Tree		
Barbary Fig		



How Are Body Systems Adapted to Meet the Needs of a Living organisms?

Activity 8

Observe Like a Scientist

Digestive System

All organisms show individual adaptations, but how do these adaptations work together? Parts of an animal's body that work together to perform a job are called systems. A system is made up of organs that work together to keep an **organism** alive.

How are other body systems adapted to meet specific needs? Let's investigate two examples: the **digestive system** and the **respiratory system**. You might not always think about how you breathe or process food for energy. You might think that all animals eat and breathe in the same way as humans. It is important to understand the difference between body systems in animals and humans.

Read the text that follows and **complete** the interactive to learn about the digestive system. Then, **answer** the questions.

Human Digestive System

Have you ever wondered what your body does with all the food you eat? Or why we need to eat food at all?

Your body gets nutrients from food. It gets **energy** from some of these nutrients. You need energy to walk, talk, or sleep. You also need energy for your body to function on the inside. You need energy for your heart to beat, your lungs to breathe, and your brain to think.

Your body uses the digestive system to get nutrients from food. The digestive system is made up of different **organs**. The organs work together to break down food into smaller parts that your body can use.

Human Digestive System, *continued*

Digestion begins in your mouth. When you take a bite of food, saliva moistens it and begins to break it down. Your teeth and tongue work together to mix and crush the food until it is soft and mushy.
When you swallow, your throat pushes the food into a tube called the esophagus. This tube has muscles that move the food down into your stomach.

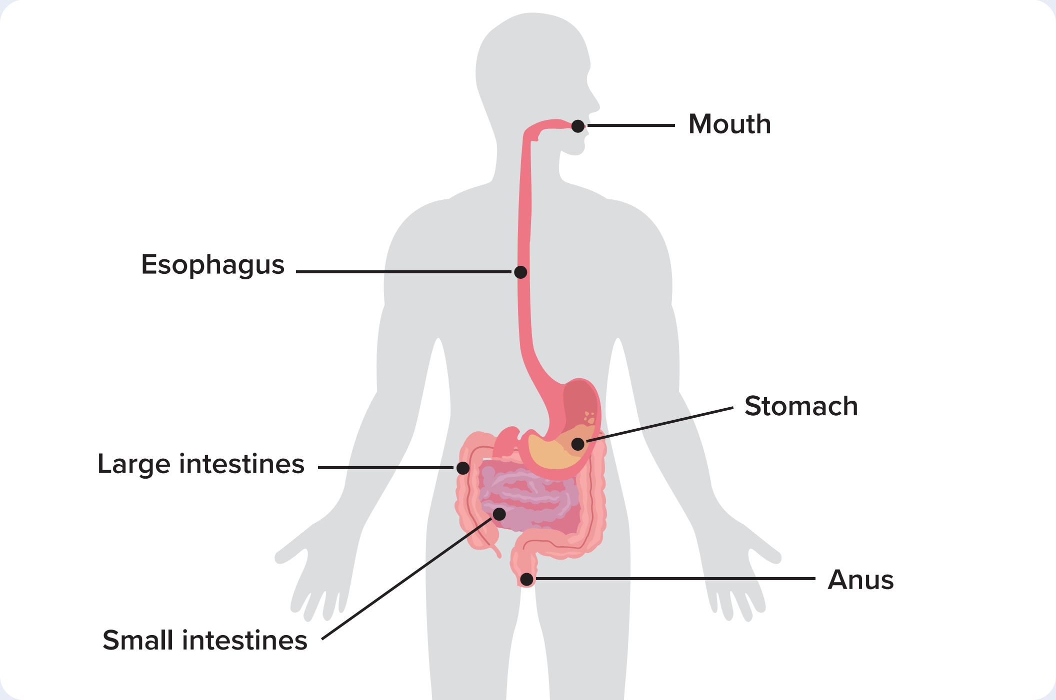


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Your stomach mixes the food with acid, digestive juices, and enzymes. Food usually stays here for a few hours until it is a soupy liquid. Next, the muscles of the stomach move the food into a long, winding tube. This tube is called the small intestine. If you stretched out the small intestine, it would be more than six meters long. Food gets broken down into small nutrients here. Juices from your liver and pancreas flow into the small intestines. They help break down the food into nutrients.

These nutrients from the food are absorbed through the walls of the small intestine. They enter into tiny blood vessels. Your blood carries the nutrients to all the parts of your body.

The body cannot use some parts of the food it consumes. These parts flow into the large intestine. The large intestine absorbs water from the undigested materials that now become solid waste. Solid waste leaves the body through the anus.



In one day, you need a lot of energy. Your heart beats around 100,000 times, you take over 20,000 breaths, and thousands of steps. It is a good thing your digestive system helps your body get the nutrients and energy it needs.

Why is digestion important?

Explain how the mouth helps digest food.

Compare and contrast the digestion that takes place in the stomach, small intestine, and large intestine.

Photo Credit: Miriam82 / Shutterstock.com

Talk Together Think about preservation methods digestive health, and determine prevention methods

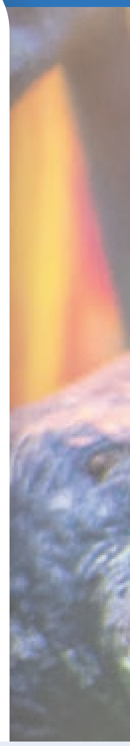


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Activity 9

Observe Like a Scientist

Respiratory System

Have you ever felt out of breath after running for a minute or two? Or noticed that sometimes your breath quickens when you need more air? Like getting nutrients from food, getting oxygen from the air is a complex process that depends on many organs working together. The respiratory system is tasked with bringing air into the body, taking out the parts we don't need, and pushing out the waste products. This process of pulling air in and pushing it out of our bodies and gas exchange is called respiration.

Still not completely sure how respiration happens? **Read** the passage that follows to learn how this system works.

How does the respiratory system work?

Our bodies need oxygen in order to function. We get oxygen from the air in our atmosphere. While it might be invisible, it is around us all the time and very important to our bodies. We cannot store extra oxygen in our body, so we must constantly take in new oxygen.

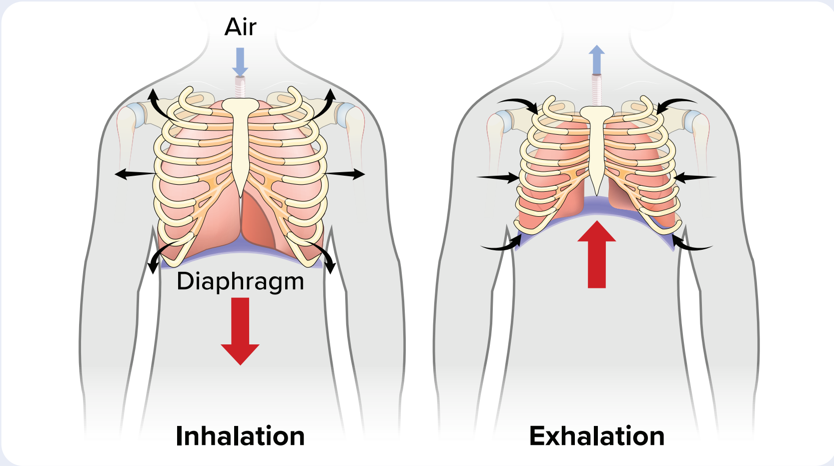
Take a deep breath. When you breathe in or inhale, air rushes in through your nose and mouth and down your throat. From there, the air travels down your trachea into your lungs. Your lungs fill up like two balloons. Now what?

Inside the lungs, two bronchi are divided into smaller and smaller bronchioles that look like the branches of a tree. At the ends of these tubes are the alveoli, which are little sacs surrounded by blood vessels. It is here that oxygen moves into your blood stream.

The process of using oxygen from the air also creates a waste product, carbon dioxide.

How does the respiratory system work?, *continued*

This gas is harmful to our bodies if it builds up. When you breathe out or exhale, your body expels the carbon dioxide back into the air through your mouth and nose.



The motion of inhaling and exhaling is directed by a large muscle at the base of your ribs, the diaphragm. As you inhale, the diaphragm shrinks, or contracts, and moves downward. This lets your lungs expand and fill up. As you exhale, the diaphragm expands and moves up, pushing air out of your lungs.

All of these processes and activities happen inside your body without you having to think about it.

Explain how the diaphragm helps us breathe in and out.

Compare the air you breathe in with the air you breathe out.

How does the respiratory system get oxygen to the body cells?

Activity 10

Observe Like a Scientist

How Fish Breathe

Have you ever tried to hold your breath underwater? How long were you able to stay under without coming up for air? Now imagine that you were a fish and could breathe under the water but not on land. How would your respiratory system need to be different?

Read the text that follows to learn about how fish have adapted to life underwater.

Unlike humans, fish do not breathe using lungs. Fish use gills to take oxygen that dissolved in water out and release carbon dioxide. Gills are found on the sides of a fish's head. Water enters the mouth of the fish and passes across the gills. Just like in our lungs, blood vessels then carry oxygen to the rest of the body. Gills are unique structural adaptations that allow fish to live and breathe underwater. How do you think water pollution impacts the fish that live nearby? Just as we need to breathe clean air to stay healthy, fish need clean water to survive.

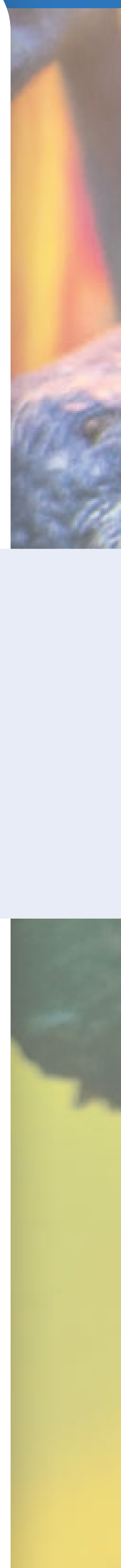


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What are the similarities between the human respiratory system and the fish respiratory system? What are the differences?

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Life Skills **I can analyze a situation.**

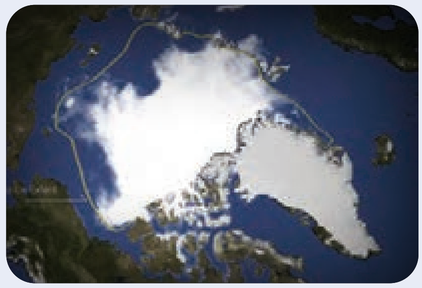
Activity 11

Analyze Like a Scientist

Humans Change the Environment

Read the text that follows and **underline** evidence that human activity contributes to rapid changes in an ecosystem. **Circle** the impacts that human activities have on plants and animals.

Humans Change the Environment



Organisms are adapted to the ecosystems in which they live; however, that ecosystem may change. That maybe other changes are caused by human activity. Humans change ecosystems when they farm, clear land, and build communities. People cut down forests and plow grasslands. They introduce plants and animals that were never part of the ecosystem. These types of changes can cause the disappearance of plants and animals that once lived in an environment.

Human activities can also pollute the air and water. The exhaust from too many cars or factories operating improperly can create air pollution. Bad habits, such as littering or dumping materials where they do not belong, can **pollute** soil and waterways. Plants and animals can be affected by changes in an ecosystem caused by humans. When the air, water, or soil in an area are no longer safe, some animals can survive by moving to another ecosystem to find what they need. Plants must rely on their seeds landing in a better place for them to survive and grow.

Humans are also affected when crops cannot grow, clean drinking water is hard to find, or smog makes it hard to breathe. People who live in cities where air pollution is a big problem are forced to change their lifestyle on days when the pollution levels are dangerous. Exposure to high levels of air pollution over a long period of time can damage the lungs and lead to conditions such as asthma and heart problems.

Just as humans can cause harmful changes, they can also help restore ecosystems. Cleared forests can be replanted, air and water pollutants can be removed, and native plants or animals can be preserved. Which impact will you have?

Talk Together Think about how the human respiratory system works. What types of human activity can positively or negatively impact respiratory health?

Activity 12

Record Evidence Like a Scientist

Penguin

You have learned a lot about how different types of adaptations help plants and animals survive. Now let's return to the examples of how a lizard stays cool and a penguin's feet stay warm. **Review** the text, and the early ideas you recorded in Wonder. Then, **answer** the questions that follow.

How can you describe penguin feet now?

How is your explanation different from before?

Once scientist have asked questions and gathered information from multiple sourses. They share what they have learned. Look at Can you explain?question. You first read this at the begining of wonder. Think about how you would answer this question now. How is your answer different from before? Record some notes about examples.

you can now use to answer the question.

Can You Explain?

How do different types of animals and plants adapt to survive in extreme climates?

Evidence

Now, **write** your new answer in full sentences to share your scientific explanation with others.

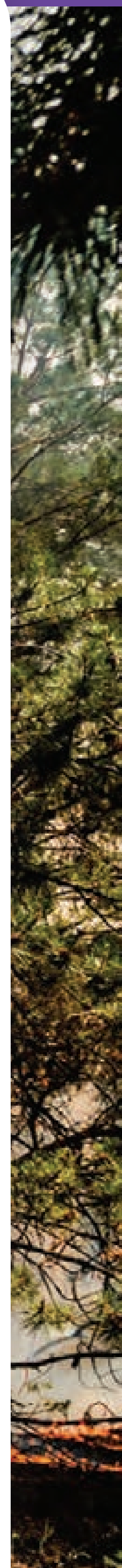


Photo Credit: Miriam82 / Shutterstock.com

STEM in Action

Activity 13

Analyze Like a Scientist

Function and Adaptation

Read the text about the work of scientists at the Amphibian Rescue and Conservation Project. Then, **answer** the questions.

Function and Adaptation

Amphibians are small animals such as frogs, toads, and salamanders that live in moist environments. Amphibians need water to survive in a different way than humans do. Take a deep breath in. You took oxygen from the air using your nose or mouth. Adult amphibians can breathe using lungs, like humans do, but they can also take in oxygen from water.


Panamanian Golden Frog

Photo Credit: K Hanley CHDPhoto / Shutterstock.com

Amphibians are covered with a skin that water and gases can pass through. As water comes into contact with their skin, amphibians extract oxygen directly from the water. This remarkable adaptation makes amphibians well-suited to wet environments like rainforests, streams, and ponds. Since these animals need clean water to stay healthy, it also makes them sensitive to the effects of pollution, habitat loss, and viruses that can travel through water.

Scientists are working to save many types of rainforest frogs from extinction. ARC scientists house a few representatives of each type of local endangered frog at their

Life Skills I can choose the best solution to a problem.

facility. Scientists study the frogs to solve the mystery behind what is making amphibians around the world disappear at alarming rates. Ninety species of amphibians have become **extinct** in the last 20 years and another 124 species are in dramatic decline. To find out what is happening to these animals, scientists must study how these animals interact with their environment and what in their surroundings is making them sick.

Advocate for Amphibians

How would you help? Compose a tweet or write a commercial slogan to convince people why clean air and water are important to frog (and human) survival. List at least two ways that people can advocate for cleaner waterways.

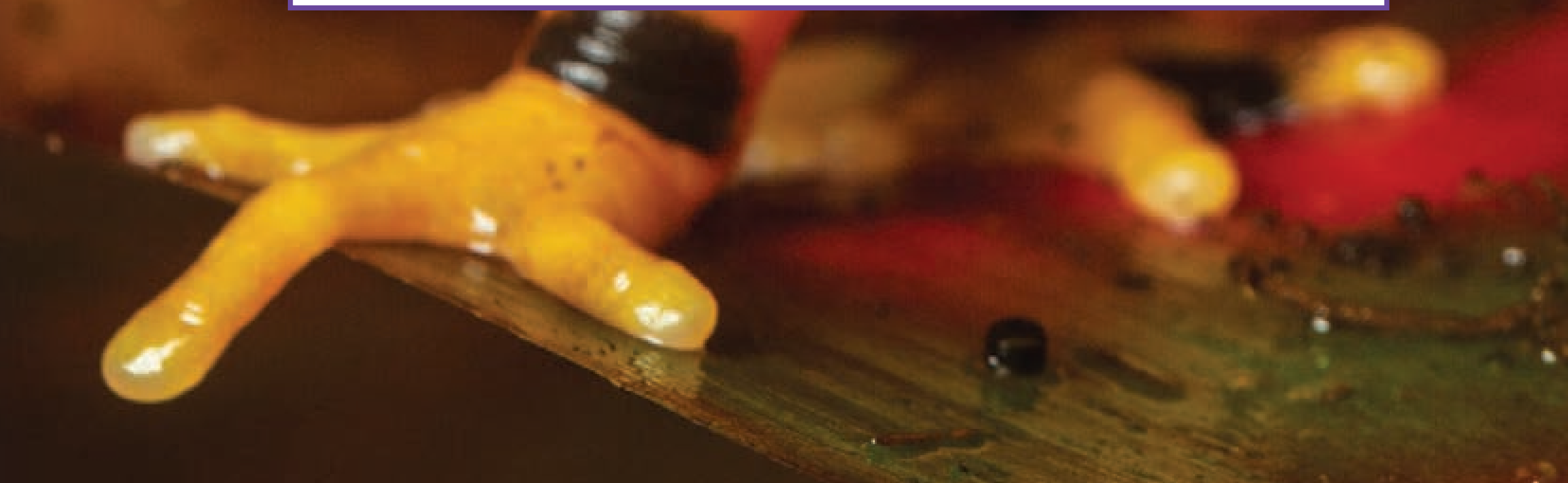


Photo Credit: K Hanley CHDPhoto / Shutterstock.com

CONCEPT 1.2

Senses at Work

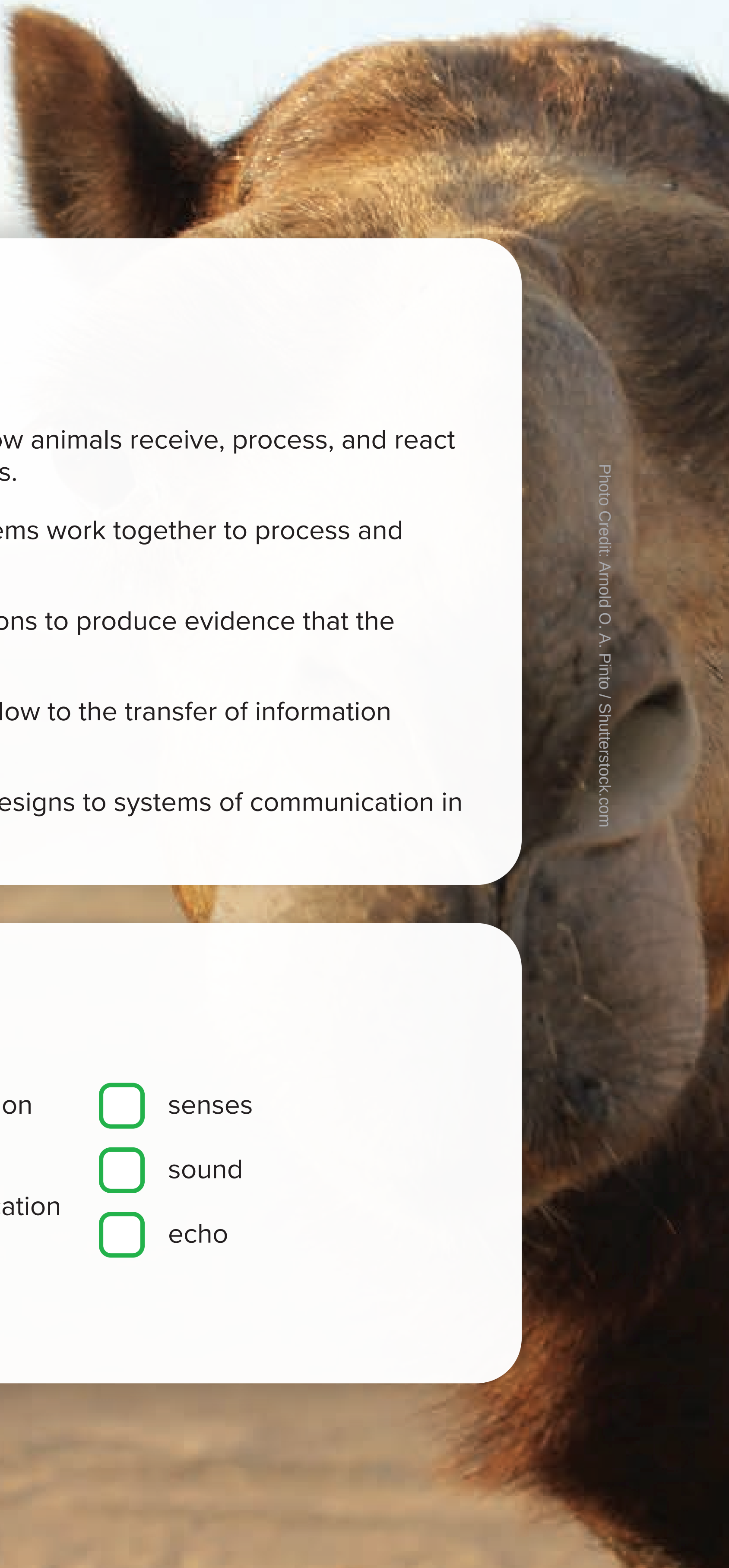


Photo Credit: Arnold O. A. Pinto / Shutterstock.com

Student Objectives

By the end of this concept:

- [ ] I can develop models that show how animals receive, process, and react to information in their environments.
- [ ] I can explain how organs and systems work together to process and respond to input from the senses.
- [ ] I can plan and carry out investigations to produce evidence that the senses play a role in reaction time.
- [ ] I can argue evidence that sound allow to the transfer of information through system of communication.
- [ ] I can compare innovative human designs to systems of communication in the natural world.

Key Vocabulary

- [ ] brain
- [ ] information
- [ ] nerve
- [ ] receptor
- [ ] echolocation
- [ ] system of communication
- [ ] response
- [ ] senses
- [ ] sound
- [ ] echo

Activity 1

Can You Explain?



In the first concept you learned about animal adaptations. You likely know a lot about human senses from previous study. Now you will connect your learning about adaptations to how animals sense the world around them, and you will know how the human and animal use senses for communication and tranfer information.

Think about the Egyptian mongoose. It communicates by combining units of sound that seem to us to be like chatter. These sounds allow the mongoose to communicate messages about movement and foraging to other mongooses.

How do animals sense and process information?

Life Skills **I can share ideas I am not yet sure about.**

Photo Credit: (a) Arnold O. A. Pinto / Shutterstock.com (b) fernando sanchez / Shutterstock.com

Activity 2
Ask Questions Like a Scientist

Dolphin Senses

As you begin to think about how senses are used, **consider** the dolphin. Does the dolphin have a super sense? **Think** about the information presented in the text, then **record** questions you may have.



The sense of hearing is important to all of us. We use our hearing to gather information about what is happening around us. Do all animals have the same sense of hearing? Is hearing the same in all animals?

Some animals seem to have super senses that help them survive. The dolphin is one of those animals. To survive, dolphins must be able to find food and protect themselves in dark murky waters. Dolphins use the sense of **echolocation** to find other life and objects in the water. The sound that a dolphin makes is transmitted in waves called sound waves that move through the water. When the sound waves hit objects, the waves bounce back to the dolphin in the form of an **echo**, which helps it locate prey. The **sound** waves that are created return to them as echoes. These echoes help dolphins determine the location of prey and other objects. Look at the word *echolocation*. What parts of the word help you remember how dolphins use their super sense to survive?

I wonder . . .

Life Skills **I can ask questions to clarify.**

Activity 3

Evaluate Like a Scientist

What Do You Already Know About Senses at Work?

Animal Perceptions

Think about what you already know about how senses work. **Read** the list of purposes in which senses are used. Then, **list** the sense used for each purpose. If you think more than one sense may be used, write all senses you think may fit the purpose. **Write** one example for each, naming the animal and how the sense is used. For example, "My pet can recognize me by scent." It is okay if you do not know all of the answers yet.

Senses: sight hearing touch taste smell

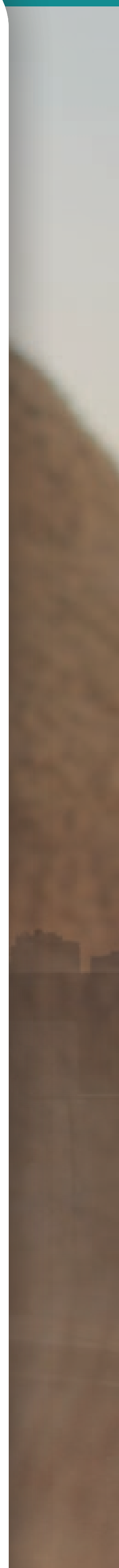
Purpose	Sense	Examples
Avoid danger		
Find food		
Recognize friends		
Identify objects		

Sensory Response

Imagine that you touch an ice cube with your index finger. Where is the information processed to tell you that it is cold? **Circle** the correct answer.

A. index finger B. hand C. nerves D. spinal cord E. brain

Talk Together Discuss one example you had that is different than your neighbor's.



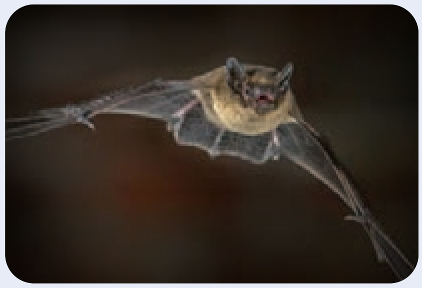
Activity 4

Observe Like a Scientist

Senses for nocturnal

Have you ever struggled to see something but found that you could use another sense to help you find it? **Read** the text that follows. **Find** evidence to explain how snakes, bats, and owls use their senses to find food, even when they cannot see it. Use what you learn to **answer** the questions that follow.

Have you ever been outside at night? It probably looked very different than it does during the day.



Animals that are most active at night are called nocturnal. There are several reasons why some animals are active at night. In extremely hot places, the best time to look for food is nighttime, when it is cooler. Some animals hunt food that is only available at night. Other creatures rely on the cover of darkness to surprise their prey.

How do these animals hunt without much available light? Super sensory adaptations allow these animals to navigate the darkness safely and find food sources. Bats rely on echolocation. Like dolphins, bats bounce sounds off objects to find food and get around. Unlike dolphins, bats must hunt in the dark. Using the "echo" that returns, bats are able to find insects at night. Owls have both extraordinary sight and hearing. Bowl-shaped faces and specialized head feathers direct distant sounds directly into the owl's ears. Sometimes animals making noises are hidden in the grass or beneath the snow. Large eyes allow the owl to see tiny, far-away movements. The ability to turn their heads nearly all the way around lets owls search for prey in every direction.



How do bats catch gnats in the dark? ______________________

How does the shape of an owl's head help it hear what it cannot see? ______________________

Life Skills **I can identify problems.**

How Do Animals Sense Their Environment?

Activity 5

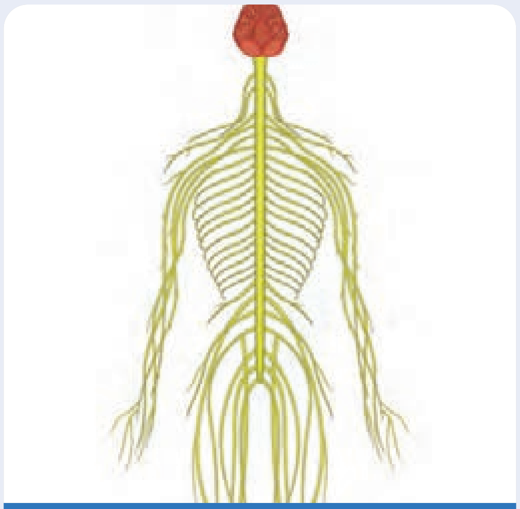
Analyze Like a Scientist

The Nervous System

Imagine you are standing outside a kitchen or restaurant. If you cannot see what is being cooked, how do you think your senses could help you figure out what food is being prepared? **Read** the passage to find out.

The Nervous System

In mammals, such as elephants, humans, and dogs, the nervous system is made up of the **brain**, the nerves, and the spinal cord. The brain is connected to a big **nerve** that runs through the backbone, called the spinal cord. The spinal cord branches out into smaller and smaller nerves that are distributed throughout the body. A few nerves, such as those from the eyes and heart, connect directly to the brain.


The Nervous System

The sense organs receive **information** from the environment. Nerves in the body connect the sense organs to the brain. Nerves are constantly receiving information from the senses and sending the information to the brain. For instance, if you smell a pizza, that information is detected by your nose. Then, nerves at the back of the nose send a specific signal to your brain. The signals travel from the sense organ along the nerves to the brain. The brain can determine what to do with the information, including how to react.

Identify and **list** the parts of the nervous system. Briefly **describe** the function of each.

Photo Credit: (a) Arnold O. A. Pinto / Shutterstock.com, (b) Anan Kaewkhammul / Shutterstock.com

Photo Credit: inigolai-Photography / Shutterstock.com

How Can Different Parts of the Body Work Together As a System?

Activity 6

Evaluate Like a Scientist

Sensing the Environment

Read the following passage to learn more about an extra-small animal with extra-large ears, the Egyptian jerboa. **Consider** the different body systems that work together to help this animal stay alive. **Think** about what you know about the human nervous system's role in responding to danger and how this compares to the jerboa reaction. **Record** your thoughts and findings.

Jumping Jerboa

Evening in the desert means it is time for many animals to wake up and hunt. For some creatures, searching for food can also mean becoming someone's dinner. Luckily, keen senses and well-adapted body parts work together to help animals survive.



The Egyptian Jerboa

The Egyptian jerboa is a desert rodent. It has long hind legs that enable it to jump a long distance. The hair on its feet and toes help grip the sand as the jerboa hops and jumps. As the jerboa hops in zigzag patterns, it can quickly escape danger.

While the jerboa looks for food, it stays alert. Vipers also search the desert for rodents to eat. Luckily, the jerboa's sensitive ears can detect even a quiet snake. When the snake makes noise, sensory **receptors** in the jerboa's ears send a message through a network of nerves to the brain. The jerboa's brain translates the message and alerts the jerboa's legs to move. This entire process happens in a fraction of a second. How long it takes the jerboa to react to danger is called reaction time. The jerboa's sharp sense of hearing and its strong legs for jumping work together with its nervous system. The way in which its senses, physical adaptations, and nervous system work together help it survive.

How does the jerboa's physical response to danger, compare to that of a human?

Activity 7

Observe Like a Scientist

How the Nervous System Works

You have just completed an investigation into your own visual and auditory senses. Now it is time to discover how our nervous system works. **Read** the passage that follows to learn how this system works. Then, **talk** together about how the parts of the nervous system are connected. Be ready to **share** your ideas.

Your nervous system is very busy. It has three jobs: gather information, make sense of it, and tell the body what to do based on that information. The nervous system gathers information about what is going on inside and outside your body and sends this information to the brain.



The process begins with your senses. Sensory organs, like your eyes, ears, and even skin, gather information. For example, your ears may pick up sound waves coming from a chirping bird. The nerves in your ears send a message to the brain. You do not actually hear the chirps until your brain makes sense of the sound waves. Next, the brain sends a message to the body about what to do, such as turn to look for the bird in a tree.

When the brain receives a message, it then sends a message telling the body how to react. Some messages, called **reflexes**, are so fast you are barely aware of them. Other messages are relayed to and from the brain automatically, like the signal to breathe.

Talk Together What role do you think reflexes played in the investigation?

Activity 8

Evaluate Like a Scientist

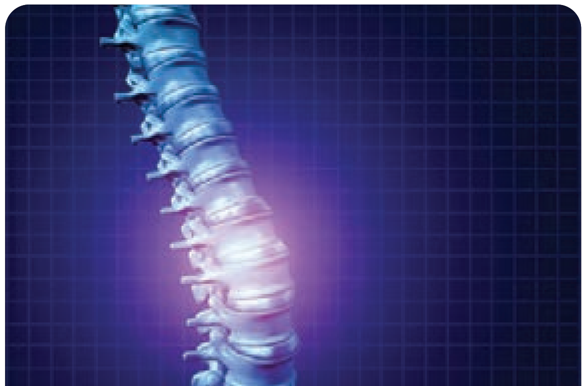
Describing the Nervous System

The Nervous System

Look at the following images. Which of these are part of the nervous system? **Circle** all that apply.



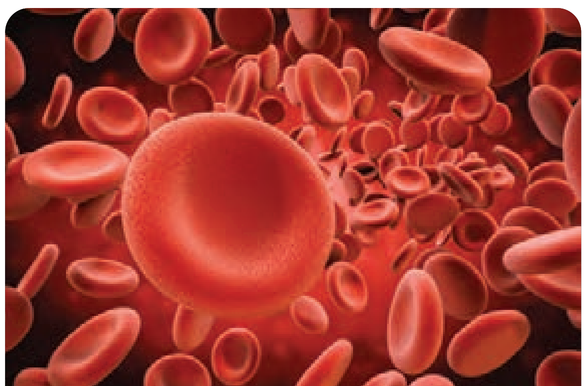
Brain



Spinal Cord



Nerves



Blood

Life Skills **I can use information to solve a problem.**

function of the Nervous System

Think about what you have learned about the nervous system and **explain** what the parts of the nervous system can do together that the individual parts cannot do alone. **Share** your answer with a partner.

____

____

____

____

Describe the Nervous System

Read the sentences that describe the nervous system. **Write** the correct term from the word bank in each blank. You will not use all the terms.

heart	brain	nerves	blood
nervous system	reaction time	reflexes	

1. The ______________________________ is like the command center for your body.

2. ______________________________ send(s) messages to the brain.

3. The brain is part of the ______________________________.

4. ______________________________ are messages sent by the nervous system that are often so fast you do not think about them.

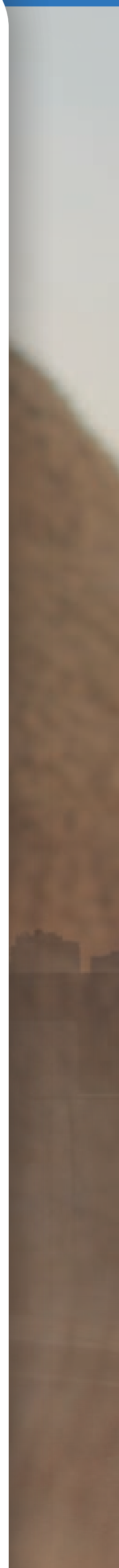


Photo Credit: inigolai-Photography / Shutterstock.com

Activity 9

Observe Like a Scientist

How Animals Use Communication Systems

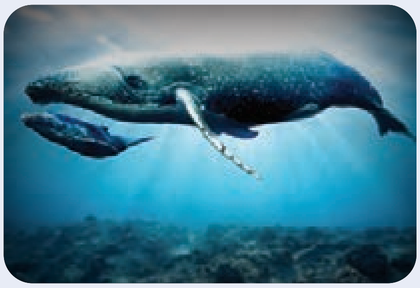
Human communication has changed a lot since people first started sharing information using written symbols. Technology systems allow us to call, text, and email messages over great distances. Animals do not use technology systems as we do, but they can still use other systems to communicate.



Photo Credit: inigolai-Photography / Shutterstock.com

Consider the tiny ant. Some ants live in colonies of thousands. Ants have developed systems that help them divide their work. Groups of ants within a colony have different roles. How do you think they communicate with each other? Would you believe they use their sense of smell? Nurse ants send smelly messages to scout ants if the food is low, ants search for food and then guide to it. The soldier ants also use smells to communicate if there is danger nearby.

Although animals do not speak like humans, they communicate whith each other using thier own **communication systems**. Animals can use different senses to send and receive information. What senses do you think whales use to communicate? **Read** the following text about whales. Highlight the facts that help you understand the ways whales communicate.



Did you know that humpback whales sing underwater to communicate with each other? These whales sing a wide range of notes and also a series of phrases in a pattern. In other words, humpback whales do not just make sounds, they make music.

Humpback whales sing during the winter months when it is mating season. They also sing during the summer months, or feeding season. However, their songs have a different sound depending on the season.

Have you ever heard people singing in a group? Some voices have a high **pitch**, or sound, while other people's voices are lower.

Explain how some animals use sound to receive and transmit information

Talk Together How are human and ant communication systems similar? How are they different?

Activity 10

Analyze Like a Scientist

Technology Inspired by Nature

Have you ever known someone who could not see because they were blind? As you read about how scientists were inspired by bat echolocation, **think** of other animal communication techniques that might help people in your community.

Bat-Inspired Technology

Many animals, such as bats, use sound to communicate with each other. But sound can be used for other purposes. Bats also use sound to get information about their surroundings. Bats use their ears to “see” in the dark. How do they do this? They use their ears for something called **echolocation**. Notice the two smaller words that make up this bigger word—*echo* and *location*. Bats make a high-pitched sound and then listen for an echo, or reflected sound. When the bat hears the reflected sound, it knows that there is something nearby. Bats use echoes to tell where and how far away objects are.



A Bat-Inspired Cane

continue, Technology Inspired by Nature

Scientists have been inspired by this adaptation to find ways to help blind people detect their surroundings. Scientists have created a cane that emits a high-pitched sound, just like bats do. The sound's pitch is too high for humans to hear. This special cane then uses vibrations to communicate information about the world to the person using it. As a person is walking with the cane, an echo from the sound is picked up by the cane. The echo is turned into vibrations that the person can feel with their thumb. The vibrating buttons tell the person the direction of the obstacles around them and how close the object is to them.

How did scientists use an animal adaptation to design a new invention?

How are the cane and bat echolocation similar?

CONCEPT 1.3

Light and Sight

Student Objectives

By the end of this concept:

- [ ] I can describe how light transfers energy across distances.
- [ ] I can develop a model that describes how the behavior of light enables the eye to see objects.
- [ ] I can explain how adaptations help some animals gather information
- [ ] I can argue using evidence that light allow for the transfer of information through system of communication.

Photo Credit: Ann in the uk / Shutterstock.com

Key Vocabulary

- [ ] feature
- [ ] light
- [ ] matter
- [ ] opaque
- [ ] pupil
- [ ] reflect
- [ ] transparent

Activity 1

Can You Explain?



In the last concept you learned about how animals sense and process information. Now you will connect your learning about senses to explore the relationship between light and vision.

Imagine the power goes out at night and you cannot turn on any lights. Which senses help you gather information about your surroundings when you have little light? Do animals use the same senses to get around in the dark? What needs to happen for humans or other animals to see an object in low-light areas?

Life Skills **I can share ideas I am not yet sure about.**

Activity 2

Ask Questions Like a Scientist

Hunting with Night Vision

You thought about how difficult it is to see when there is not much light. **Consider** other animals. Do you know of any animals that can see in the dark? **Read** the text. Then, **discuss** what you notice about how your own vision works at night, record your qustion.

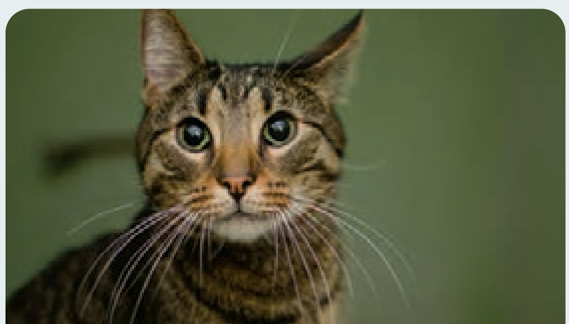


We use our sense of sight to gather information about what is happening around us. To see well, our eyes require **light**. Without light, we would need a set of night vision goggles to see in the dark. This is not true for all animals though. The fishing cat is a wild cat that hunts for food at night. These animals are able to find their prey in the dark because of the structure of their eyes.

The fishing cat's eyes seem to glow in the dark. The reason they do this is because all cats have a mirror-like membrane on the back of their eyes. As light enters, it bounces off this membrane, allowing the eye to collect more available light. This adaptation (structural adaptation) allows cats to have excellent night vision that they use to hunt successfully in the dark.

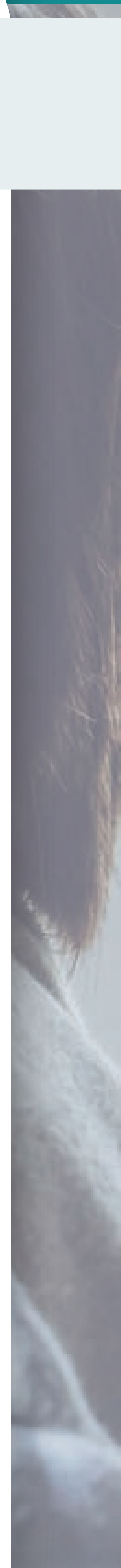
Humans have difficulty seeing in the dark, but nocturnal animals are better able to see. Why is this so?

Many nocturnal animals have spectacular night vision. As you read in the Investigative Phenomenon, some animals have eyes that are different than ours. There are many differences between the eyes of a human and a nocturnal animal. To start, nocturnal animals have bigger eyes than humans.



Cat Eyes in the Dark

The **pupils** of their eyes usually open wider than ours, letting in more light. Many nocturnal animals also have other senses that are heightened, such as hearing and smell, that help them hunt and move about in the dark.



Write your questions you have and then **share** them with a partner.

I wonder . . .

After reading and observing, **complete** the table to **explain** the abilities of humans, cats, and tarsiers to see in dark places.

Adapting to the Dark	
Humans	**Cats**

Photo Credit: inigolai-Photography / Shutterstock.com

Activity 3

Evaluate Like a Scientist

What Do You Already Know About Light and Sight?

Sources of Light

A source of light is something that gives off its own light. There are objects that **reflect** light. These objects are not considered a source of light. **Look** at the pictures. **Circle** the pictures that show sources of light.



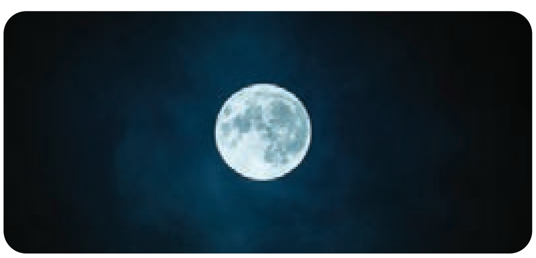












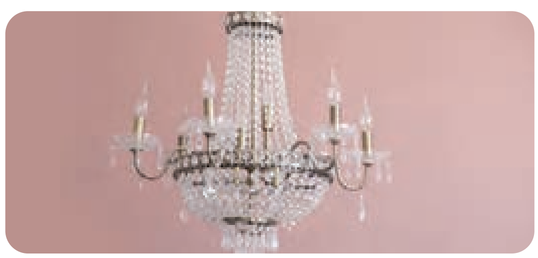


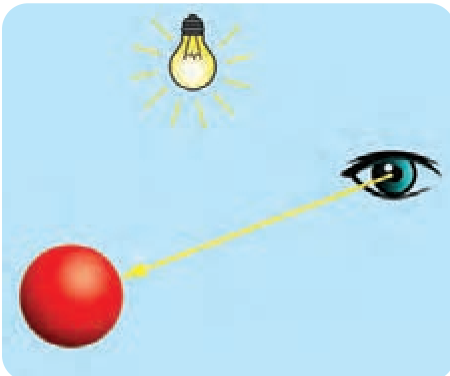
Photo Credit: (a) Ann in the uk / Shutterstock.com, (b-c) Paul Fuqua, (d) HAKINMHAN / Shutterstock.com, (e) Dragance137 / Shutterstock.com, (f) Sergey Tinyakov / Shutterstock.com, (g) Pedrosala / Shutterstock.com, (h) Anvar Ianbaev / Shutterstock.com, (i) Pixabay

Photo Credit: inigolai-Photography / Shutterstock.com

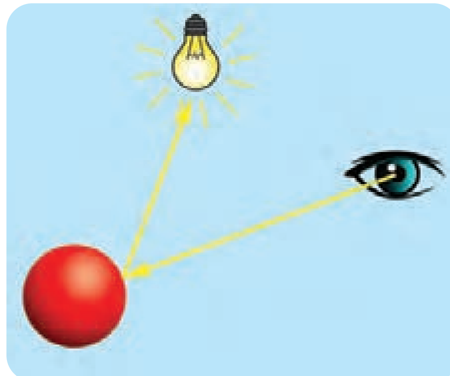
How We See

Diagrams can be used to help us understand how we see objects. Look at the images below. The yellow arrows represent the paths that light might travel. **Circle** the image that best shows what happens when you see a red ball.

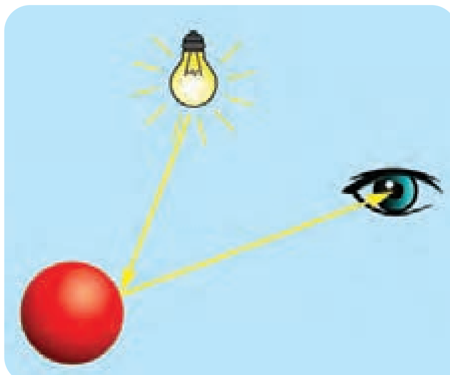
A.



B.



C.



Light has an effect on ability to see. In order for humans to see an object, light must fall on the object and be reflected into to our eyes. Structures in human eyes transmit messages to the brain to tell us what we are seeing.

What Happens When Light Strikes Matter?

Activity 4

Investigate Like a Scientist

Hands-On Investigation: Reflection

During the last activity, you learned about a special feature in some animals' eyes that reflects light and improves night vision. In this activity, you will investigate how light interacts with different types of materials. **Use** your flashlight to **investigate** which objects are reflective and which are not. **Identify** qualities that are common in the reflective materials.

Make a Prediction

Which objects do you think will reflect light best? **Write** and **explain** your prediction.

What Will You Do?

1. Choose four objects of different materials to investigate.
2. Shine your flashlight on each object.
3. Observe how the light interacts with the material.
4. Record how well the material reflects the light.
5. Fill in the table with your results.

What materials do you need? (per group)

- Flashlight
- Various objects made of different materials (such as a plastic block, wooden block, piece of cloth, mirror, paper, piece of metal,

HANDS-ON INVESTIGATION

Life Skills **I can analyze a situation.**

Material	Observations	Is this what you expected to happen?

Think About the Activity

Review your prediction. Did the results of the investigation provide evidence that supported your prediction? Or did they provide evidence against your prediction? **Describe** how you know.

Based on your results, which types of materials reflect light the best? Which reflect light poorly? **Explain** your answer.

Draw a picture of your results showing the paths of the reflecting light rays.



Activity 5

Analyze Like a Scientist

Light Strikes Different Matter

Think about what you have learned about how different materials reflect light. There are many ways that light interacts with matter. **Read** the text that follows. **Consider** how the way in which light interacts with objects affects your ability to make observations of the world around you. Then, **answer** the question that follows.

Light Strikes Different Matter

Light is a form of energy that travels in waves. When traveling light hits an object, some of its energy is absorbed. Some of the energy may go through the object. Some of the energy bounces, or reflects, off the object's surface. You can examine these behaviors of light by observing different objects. Some objects, including your body, make shadows. This happens because light that hits your body either bounces off or is absorbed. None of the light passes through you. Objects that light cannot pass through are called **opaque**. **Transparent** objects or substances, such as air, water, windows, and lenses, allow light to pass through, which is why you can see through them.

When light hits an opaque object, some of it is absorbed. The rest of the energy bounces, or reflects, off. How the light is reflected depends upon the smoothness of the surface. If the surface is a polished mirror, the rays reflect off differently than from a painted surface, which is slightly rough. When light hits an opaque object, some of it is absorbed. The rest of the energy bounces, or reflects, off. How the light is reflected depends upon the smoothness of the surface.

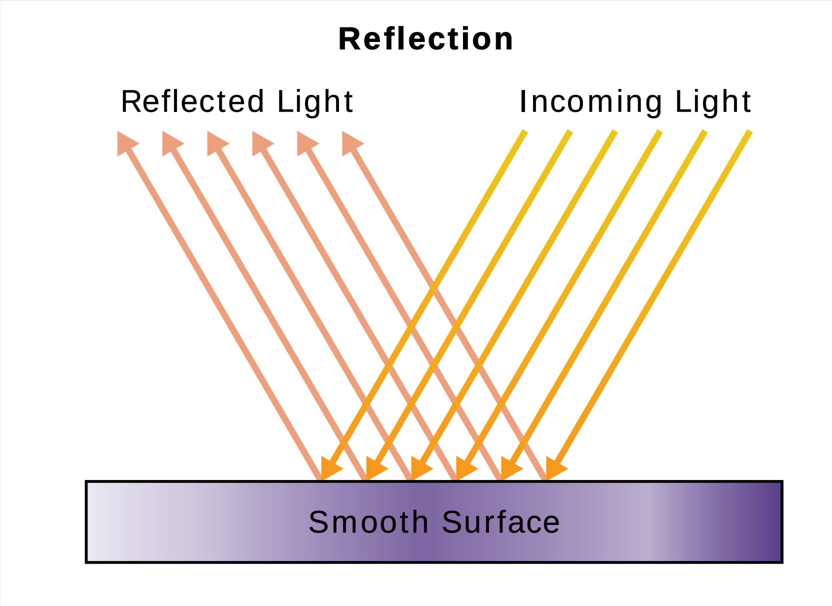


Reflecting Light

Photo Credit: Dynamicfoto / Shutterstock.com
Photo Credit: inigolai-Photography / Shutterstock.com

If the surface is a polished mirror, the rays reflect off differently than from a painted surface, which is slightly rougher. Rough surfaces scatter or diffuse light.

How does light striking **matter** make it possible for animals, including humans, to see? Light waves bounce off objects around us. The reflected light then travels in a straight line into our eyes. In the eyes, special nerves send messages to the brain.



Your dropped cell phone, and now the screen has a few cracks. How do you predict that light will reflect off the screen compared to before it was broken?

____

____

And what is the result of that?

____

____

Activity 6

Record Evidence Like a Scientist

Firefly Light Show

Have you ever seen a firefly? Why do you think they light up? **Read** the text to learn about firefly behavior and an interesting art show. Consider what you have already learned about adaptations and senses. How does this scenario add to what you know? When you finish, respond to the questions in writing.

Do you see the light show in the photo? It is set in the mangroves of Thailand, but the lights are not produced by humans. They are produced by thousands of fireflies. Fireflies produce a chemical reaction inside their bodies that allows them to light up.



Photo Credit: inigolai-Photography / Shutterstock.com

Fireflies are not flies at all. They are actually winged beetles that flash to warn off predators or to attract a mate. Fireflies naturally flash at regular intervals, but if there is another firefly flashing nearby, they will interrupt their own pattern and start over again to match the other firefly.

How are senses used by the firefly?

How have humans used light to commuicate with others in sending and receiving information?

Activity 7

Evaluate Like a Scientist

What Do You Already Know About Communication and Information Transfer?

You learned how animals have adapted to use their senses, such as hearing and sight to gather information from the world around them.

Now, you will learn how humans and other animals use sound and light to communicate and share information.

Animals and Humans

Think about what you already know about how humans and other animals communicate. As you prepare to further investigate communication and transfer of information, think about how communication is similar and different in animals and humans.

Read the list of ways people and animals communicate. **Classify** each type of communication in the table as animal (A), human (H), or both (B). Think of two more examples to complete the table.

Type of Communication	Animal (A) or Human (H) or Both (B)
Displaying light	
Writing	
Echolocation	
High-pitched sound	
Mobile phone	
An e-reader	



Photo Credit: inigolai-Photography / Shutterstock.com

How Do We Transfer Information?

Activity 8

Analyze Like a Scientist

Transferring Information

We use our senses of sight, touch, taste, hearing, and smell to collect information about the world around us. The senses can also be used to communicate, or share information, with others. Imagine your friend is smiling at you. Which sense do you use to understand they are happy? **Read** the text. As you read, **highlight** anything you do not understand with a blue highlighter and anything you find interesting with a yellow highlighter.

Transferring Information

Your sense organs collect information about your environment and send it to your brain. Examples include your ears detecting sound energy and your eyes using light energy to gather information. For a moment, think about all the different kinds of information that you receive through your eyes. Your eyes detect light. This means they can detect signals that travel very fast over different distances, such as your friend waving from across a room, a traffic signal, or a rescue flare. In the past, people used signal fires to communicate over distances of many kilometers. Many backcountry hikers carry mirrors that they can flash to attract the attention of pilots of rescue helicopters.



Traffic Signals

Photo Credit: inigolai-Photography / Shutterstock.com

Humans use signals or codes to transmit information. They can be as simple as a thumbs-up or thumbs-down, or a red or a green traffic light. Expressions on our faces are coded signals that can help people predict what we are thinking or whether we feel happy or sad. Language is a code in sound. Different languages are different codes, but they all enable the transfer of information. Writing is a **code** that uses symbols. A code is a pattern that has meaning, such as the arrangement of letters in a word. Music or sound can be used to communicate messages. Lighthouses encode information in flashes of light that tell sailors where they are. When sense organs receive this information and send messages to the brain, the brain decodes and interprets the meaning.

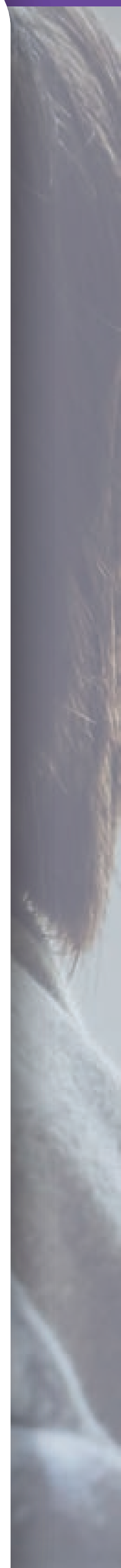
Activity 9

Evaluate Like a Scientist

Review: Communication and Information Transfer

Think about what you have learned so far in this concept about how humans and other animals communicate. Animals use a variety of ways to communicate, and humans have a much more complex system of communication. As you review this concept, use the space provided to **summarize** your learning. **Explain** the similarities and differences between how humans and animals communicate. If you have additional questions about communication systems, **write** them here and **share** these with your teacher and classmates.

Talk Together How does your new understanding of communication systems help you better understand bats? Talk to your partner about how you can use your knowledge of adaptations, senses, and communication to get ready for the Unit Project.



Solve Problems Like a Scientist

Unit Project: Bat Chat

In this project, you will research bats to learn how their adaptations help them to navigate and communicate.

Read the text about echolocation. **Underline** the ways bats use sound.

Chattering Bats

Many creatures use sound to communicate with each other. But sound can be used for other purposes. For example, bats use sound to communicate with each other. They also use sound to move around in the dark.

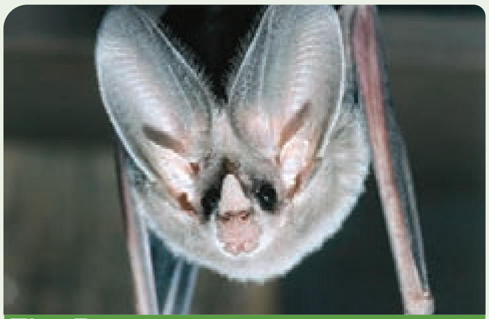

The Bat

Photo Credit: inigolai-Photography / Shutterstock.com

Bats also communicate with each other using sound. Bats make different sounds that mean different things, just like people communicate with words.

Most of the sounds are too high for humans to hear. Researchers use recording devices that can measure the sound. They have decoded many of the sounds bats make and have found that most of the sounds are arguments. Bats argue almost constantly. They argue about food. They argue about where they get to sleep. They argue about which bats they get to have as mates.

Echolocation

Research bats further by using print or online sources. **Learn** about the ways bats have adapted to use sound to navigate, hunt, and communicate. Then, **draw** a diagram of about using sound to avoid obstacles and find prey.

Label all relevant parts of the diagram. Be sure to include the way the sound interacts with the bat, the obstacles, and the prey.

Life Skills **I can work to meet expectations**

Bat Chat

Bats communicate by using different sounds to mean different things, like humans use language. Bats also hunt and fly in the caves where they live some times of their life, and they do so using echolocation.

Explain why it is helpful for bats to have different sounds that mean different meanings and things, given these facts. **Use** a Claim-Evidence chart to organize your thoughts.

Claim

Evidence

Photo Credit: inigolai-Photography / Shutterstock.com

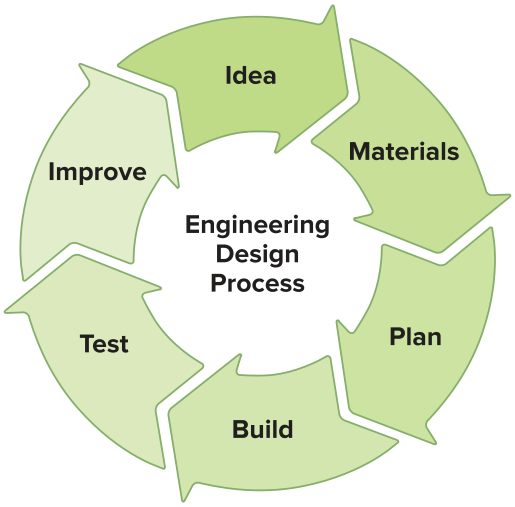


Photo Credit: inigolai-Photography / Shutterstock.com

Interdisciplinary Project: To Get to the Other Side

Quick Code: egs4430

In this interdisciplinary project, you will use your science and math skills to find a solution to a real-world problem. First, you will read a story about a fictional group of characters, called the STEM Solution Seekers. Then, you will study some background information, and you will design, test, and refine a solution to the overall challenge. You will go through the steps of the Engineering Design Process, as shown below. You will also do some additional work in your math class related to this challenge.



The project "To Get to the Other Side" challenges you to think about all of the members of a community and how we as humans affect other living organisms. In the story, you will read about a population of desert lizards, called the blue Sinai agama, who have been impacted by a new sidewalk. You will learn more about the habitat and needs of the agama, and then you will design a solution to help them survive.

To Get to the Other Side

Maher, Laila, and Galal are looking for the Sinai agama lizards that they usually see on their walk home from school.

"I can't find any. Where'd they all go?" asks Laila.

"Professor Hassan said there were lots of them here," says Maher. He is using a stick to poke in the sand and gravel at the edge of the sidewalk.



Photo Credit: inigolai-Photography / Shutterstock.com

They keep searching but don't find any lizards. As they grow tired of looking, Laila says, "I wonder why we can't find them. I think we need to ask Professor Hassan." Maher and Galal smile as all three start to run down the sidewalk to her house.

The friends talk over each other as they explain the problem to Professor Hassan. "There were plenty of Sinai agamas in that area before they built the new, wider sidewalk a few months ago," she says thoughtfully.

Galal thinks a minute and then wonders, "Why don't we get rid of the sidewalk and see if they come back?"

"The sidewalk helps everyone. Now we can walk and ride bikes and scooters to school and other places," Laila says. "My mom said the sidewalk helps keep us safe."

"The path is a good thing," says Professor Hassan nodding. "I think we need to find out more about the Sinai agama and why you couldn't find any there," she says. She starts tapping on her computer.

A woman in a lab coat pops up on the screen and says, "How can I help?" The children smile and Galal starts asking questions. Maher begins to tell the woman about their search for Sinai agamas. Professor Hassan motions Galal and Maher to be quiet so Laila can explain the problem to the woman.



Photo Credit: inigolai-Photography / Shutterstock.com

"Laila, did you and your friends notice anything else that is different in the area?" Laila thinks for a moment and reflects, "We remember seeing a lot more rocks in the area before the sidewalk was widened."

After chatting for a few more minutes, Laila signs off and turns to her friends. "Professor Hassan's friend told me that the new sidewalk may have disturbed the Sinai agama's habitat," Laila announces. "We need to figure out what the lizard's habitat looks like" says Galal.

"We need to be sure the sidewalk allows access to plenty of tall rocks that the Sinai agama like to sit on and hide under while looking for prey," Laila says.

Maher looks at some extra, unused items and says, "Maybe we can use some of this stuff to model a better habitat for the Sinai agama."

"I think you three are ready to figure out how to help the Sinai agama in our community!" says Professor Hassan as Maher, Galal, and Laila begin to talk about how they might help.

The Sinai Agama

(Blue agama)

The Sinai agama is a lizard that can be found in the dry and rocky environments of Eastern Egypt. In order to survive the hot, arid climate of this region, this little reptile has developed unique features and behaviors that allow it to live and hunt in this harsh environment. Some of these adaptations include standing on the top parts of its toes so that its belly stays high above the hot rocks, scaly skin that traps in water and having a long, thin body that helps it climb and run quickly.



(Blue agama)

The Sinai agama is active during the hottest parts of the day and likes to hang out in areas with many rocks, hard gravel surfaces, and volcanic boulders. They save energy as they wait in the dark spaces between the rocks for their prey to come by so that they can launch an attack. Males often perch on lookout rocks to guard their territory. During the late spring breeding season, the males turn a vivid blue color in order to attract a mate. Females remain the grey-brown color that helps these lizards to camouflage in the desert



Their diet consists mainly of ants, grasshoppers, beetles, termites and other insects. Tongues with surfaces that are as sticky as bubble gum allow the lizard to catch and hold on to their prey. The number of Sinai agama lizards in the wild is negatively affected by humans. Whether it is people making changes to their natural habitats or catching them so that they can be sold as pets, these little lizards would prefer to be left alone so that they can sit and wait for the next unlucky insect to come their way.

Hands-On Investigation

Engineering Your Solution

Challenge

You have been asked to create a solution for a sidewalk design that meets the needs of both humans and Sinai agama lizards. This activity will guide your team through the Engineering Design Process.

Objectives

In this activity, you will . . .

- Review the challenge requirements and assign roles to each member of your team
- Create three or four sketches to brainstorm solutions
- Agree upon one final blueprint for your prototype
- Create a prototype of your solution that helps the Sinai agama return to their habitat



A Desert Agama Habitat

Photo Credit: inigolai-Photography / Shutterstock.com

What materials do you need? (per group)

- Building materials, such as craft sticks or small pieces of wood
- Construction paper or cardboard
- Pebbles, small rocks, and/or clay
- Sand, small sticks, leaves, dirt
- Toy animals or figures to represent living organisms in the habitat (optional)
- Blank paper or poster board

Procedure

Follow these steps with your teammates:

1. **Review the Challenge** Study the requirements from the school and the needs of the Sinai agama.
2. **Assign Group Roles** Decide the roles for the members of your group and record the names next to each role.
3. **Sketch Ideas** After brainstorming, as a team, select three or four ideas to plan out in the Sketching Our Design boxes. Review your sketches and decide on one design to fully develop. Add more details to make it your blueprint that you will use to help you create your solution.
4. **Plan and Build** Gather materials and begin building your prototype. Make sure to keep track of your steps and process.
5. **Reflect and Present** When finished, review your product and your process. Identify ways you could improve. Prepare to share with your class.

Design Requirements

- [ ] Your solution must include a diagram and small prototype of your sidewalk design, as well as a presentation sharing both your prototype (product) and how you worked together as a team (process).
- [ ] Your solution can only use materials the school has available: planks of wood, concrete, gravel, and natural materials found near the path, such as different size rocks, sand, dirt, sticks, and fallen leaves.

Life Skills **I can review expectations.**

Sketching Our Design

Within your team, discuss these two questions for your ideas:
What do you like about these ideas? Where can you make improvements to the designs? Circle your final design to create.

Plan and Build

STEP 1 Now that you have selected one design idea, create a separate diagram with additional details that you will share during your presentation. This detailed diagram is the blueprint for your prototype. Identify any materials you will use on the detailed diagram.

STEP 2 Gather the materials you identified in your blueprint. You may need to make adjustments to these materials as you are building. Keep track of what you actually use.

STEP 3 Begin building your prototype. As you build, you may run into problems

Life Skills **I can use information to solve a problem**

or challenges. Focus on one problem at a time and use your group's creativity and collaboration skills to find solutions. Engineers use notebooks and documentation to troubleshoot when things go wrong so that they can look for places to make improvements.

STEP 4 Once your prototype is complete, work with your team to create a presentation to share both your product and your process. Be sure to explain the parts of your prototype that help all of the living organisms in the habitat. Also make sure to prepare to share how your team worked together, if you encountered any problems, and how you worked to make improvements.

Analysis and Conclusions

Reflect on the following questions:

1. How does your solution meet the needs of people and Sinai agama?

2. How do you know your design is successful? What could you do to test your design?

3. What improvements would you make to the design process or to your final prototype?

4. What was your role on the team? What did you do well? What improvements could you make?

Assess your learning

Choose the correct answer from the following:

1. ………………..is considered a behavioral adaptation in living organisms.
   A- Long ear B- Live in burrows
   C- Big eyes D- Color contrast

2. …………… is considered a structural adaptation in living organisms.
   A- Birds migration B- Panting
   C- Brown fur D- Inflating the body to make it appear larger

3. The following animals are structurally adapted except for ………..
   A- penguin B- fennec fox
   C- arctic fox D- polar bear

4. Some plants have very wide leaves in order to………..
   A- To prevent tearing due to wind
   B- To prevent animals from eating it
   C- Reduce water loss
   D- Get sunlight

5. Which of the following groups reflects light well when it falls on it?
   A- A mirror - A wooden board - A metal spoon
   B- a metal spoon - a cardboard box - a mirror
   C- Mirror - aluminum foil - metal spoon
   D- Aluminum paper - brick - mirror

6. The aluminum…………. feature helps to see yourself in the mirror.
   A- refraction B- reflection
   C- absorption D- density

7. When exposed to danger, the ……… system helps to recognize it and avoid it
   A- circulatory B- digestive
   C- respiratory D- nerve

Compare each of the following:

1. The inhaled air and the exhaled air when the breathing process occurs in a person.
2. Structural adaptation and behavioral adaptation of a living organism.
3. Communication in humans and communication in animals.

Read the statements and determine if each is true or false. Write "true" or "false" on the line next to each.

1. Your sense of hearing allows you to see the light from a flashlight.
2. The stomach is an important organ of the digestive system.
3. Your sense of touch allows you to feel the heat from the stove.
4. The esophagus is an important organ of the respiratory system.
5. The ear is the organ of feeling that allows you to hear birds singing .
6. The lungs are important organs of the respiratory system.
7. The eye is the organ of feeling that allows you to taste the bitterness of a lemon.
8. The heart is an important organ of the nervous system.
9. Skin is the sensory organ that allows you to feel the softness of the fabric.
10. The diaphragm is an important organ of the digestive system.

Complete the sentences using the correct words from the following words in brackets:

(Touch - Hearing - Light - Eye - Ear - Heart - Brain - Respiratory System - Lung - Stomach - Digestive System)

1. The sense of ______________ allows you to notice noise, ____________ sends a signal through the nerves. The signal goes to _____________, and you interpret that sound as the song of a bird.
2. The system that digests food to produce energy is _______________. The most important member of this system is ______________, and the system responsible for providing the body with oxygen is ____________

Answer the following:

1. Why is vision different at night between cats and humans?
2. Bats cannot see in the dark, but they can hunt their prey at night

Theme 2 | Matter and Energy

Unit 2 Motion

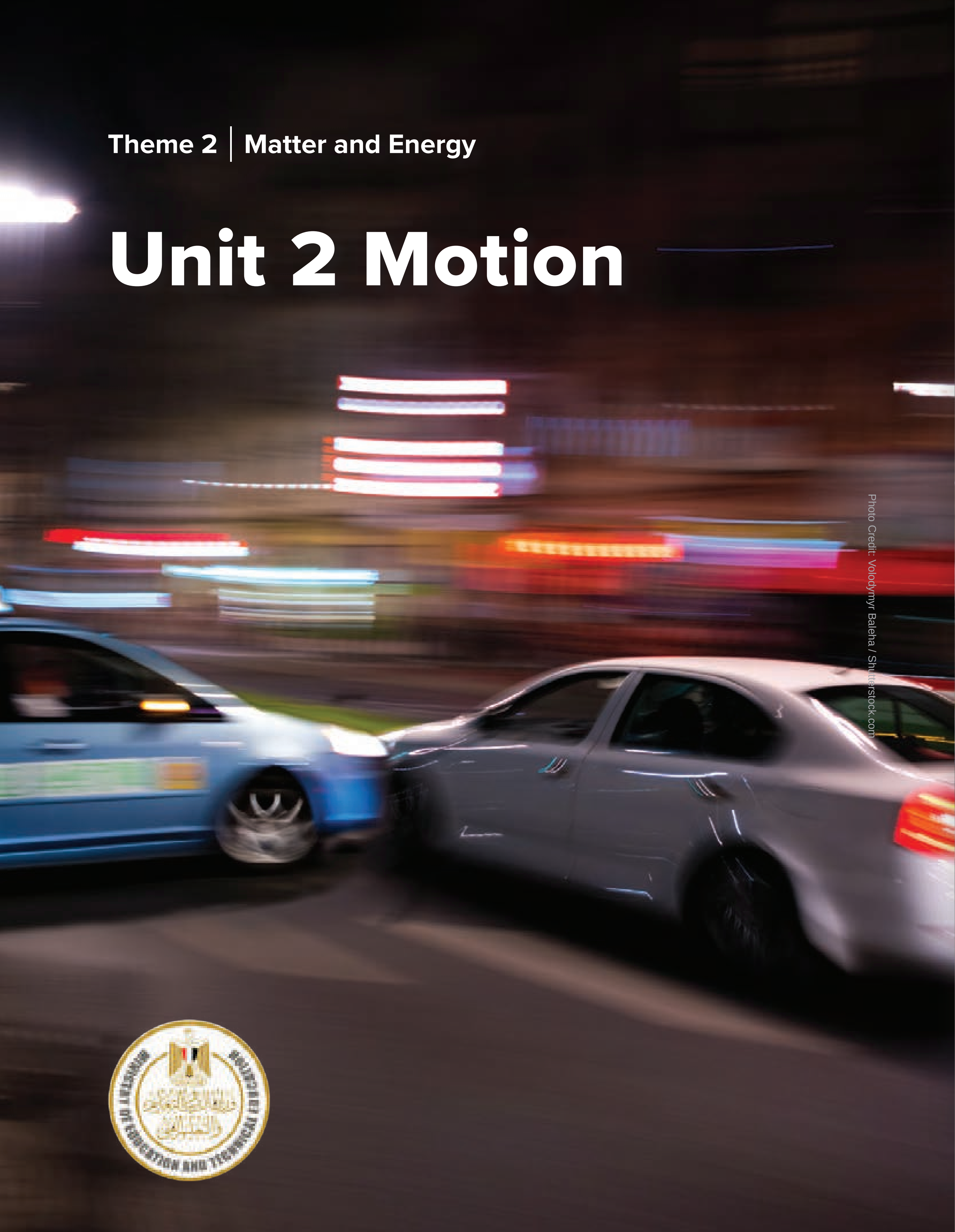


Photo Credit: Volodymyr Baleha / Shutterstock.com

What I Already Know

This unit is all about energy and motion. **Think** about objects that move. Do all objects move in a specific way?

Look at the image of the man in the wheelchair on the ramp. How do you think the man and his wheelchair will move? Will he need additional force to move? Will the ramp help his movement?



Wheelchair at the Top of a Ramp



Talk Together Think about the energy required to move objects like a car or a train. Share your ideas about where the energy for motion of vehicles comes from.

During this unit, you will learn a lot more about how energy and motion are related. You will explore starting and stopping motion and how energy changes when forces are applied to objects. You will learn the relationship between energy and work, which happens when forces move objects. You will investigate speed by looking closely at the distance objects travel when moving and how long they travel. Finally, you will investigate what happens when objects collide, or crash together.

Photo Credit: (a) Volodymyr Baleha / Shutterstock.com, (b) UfaBizPhoto / Shutterstock.com

Science and Car Crashes



You may have witnessed a car collision and the damage caused by that collision. Lots of things happen in a car crash. There is a lot of noise. Things get broken and thrown about. Cars and other vehicles are built with a lot of safety features to help prevent damage to passengers, but sometimes the force of the crash or collision is too great and people can get hurt. During this unit, you will learn more about what happens when cars or other objects collide and why there is the potential for so much damage.





What makes the vehicles we ride in start and stop? How do cars get the energy to move? Why should you wear a seat belt while riding in a car? How are buses and cars similar and how are they different? What other forms of transportation are common in your community? How can you stay safe as a pedestrian in an area with a lot of traffic?

Solve Problems Like a Scientist

Unit Project: Vehicle Safety

In this project, you will use what you know about energy, motion, and collisions to research and redesign a safety feature of a passenger vehicle. You will design, test and refine a device that transfers the energy of impact into a mechanism that will protect passengers from injury during a collision.



Car Crash

Ask Questions About the Problem

You are going to research and then redesign a safety feature of a passenger vehicle. **Write** some questions you can ask to learn more about the problem. As you learn about energy, motion, and collisions in this unit, **record** the answers to your questions.

Life Skills **I can use information to solve a problem.**

Photo Credit: (a) Volodymyr Baleha / Shutterstock.com, (b) Tharin Sinlapachai / Shutterstock.com

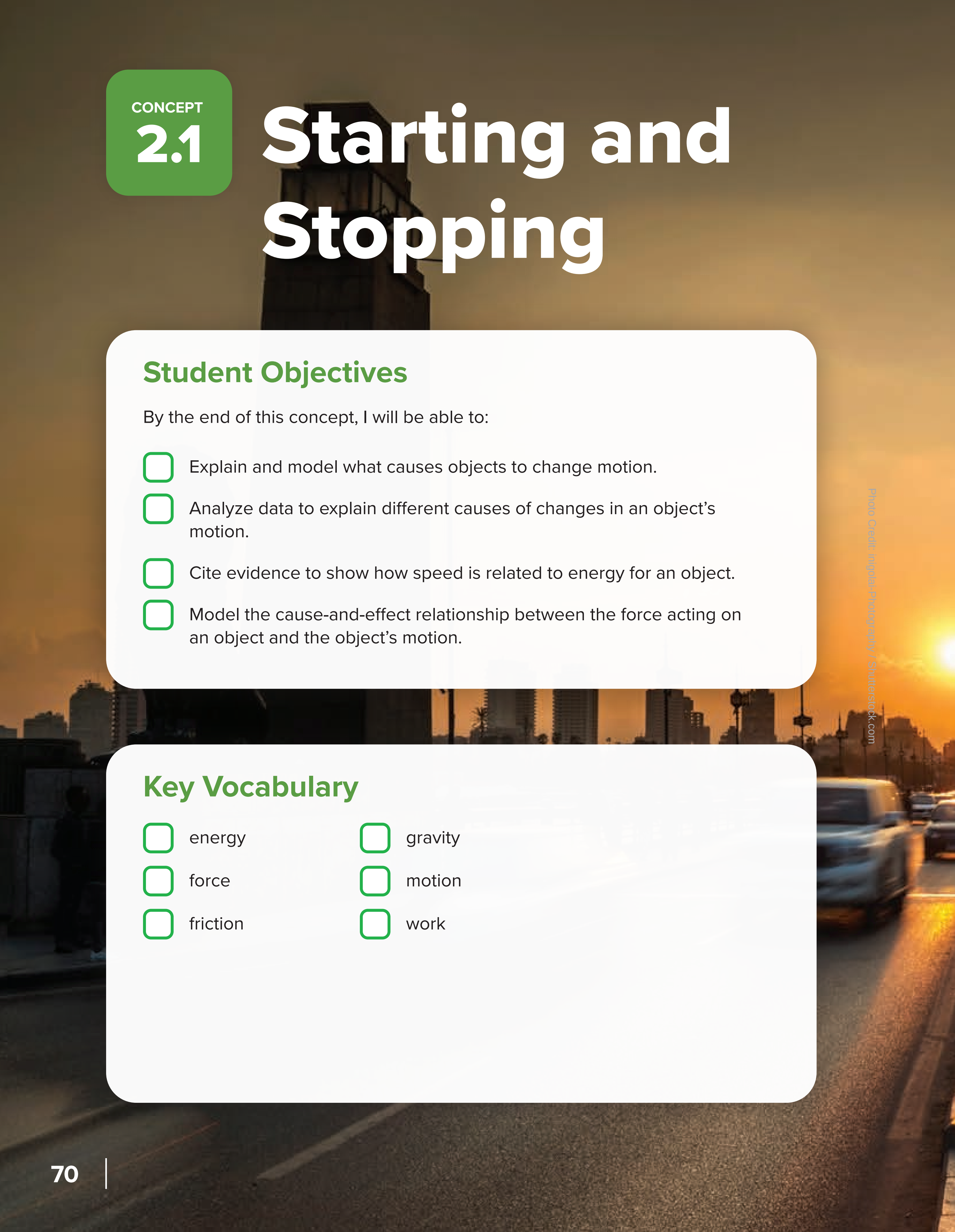


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CONCEPT 2.1

Starting and Stopping

Student Objectives

By the end of this concept, I will be able to:

- [ ] Explain and model what causes objects to change motion.
- [ ] Analyze data to explain different causes of changes in an object's motion.
- [ ] Cite evidence to show how speed is related to energy for an object.
- [ ] Model the cause-and-effect relationship between the force acting on an object and the object's motion.

Key Vocabulary

- [ ] energy
- [ ] force
- [ ] friction
- [ ] gravity
- [ ] motion
- [ ] work

Lesson 1

Activity 1

Can You Explain?



When is the last time you rode in a car, bus, or train? How do you think that vehicle started? What does it take to stop a vehicle? As you begin this unit on motion, think about what you already know about force and energy.

How do forces act on a starting and stopping object?

Life Skills **I can share ideas I am not yet sure about.**

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Activity 2

Ask Questions Like a Scientist

Truck versus Airplane

Have you ever wondered how something that is moving very fast slows down or stops? **Use** the text provided to **investigate** the forces involved in starting and stopping. Then, **write** two questions you have.



Have you ever seen a jet flying overhead? What about a truck driving along a motorway? Which do you think is moving faster?

The engines on a jet are much more powerful than the engine in a truck. Normally, jets fly much faster than a truck can drive. So what would happen if you put a jet engine on a truck? The truck featured, named the Shockwave, has been fitted with three jet engines. It can reach speeds of over 500 kilometers an hour—about five times faster than the trucks you see driving down the motorway.

The powerful engines help this truck start moving and reach record speeds, but how does it stop? To solve this challenge, the truck's engineers turned to rocket designs. They installed three parachutes that deploy to help slow down the truck quickly.

What makes the truck move? How does the truck start and stop?
Write your questions you have, and **share** them with the class.

I wonder . . .

Life Skills **I can ask questions to clarify.**

Activity 3

Observe Like a Scientist

Making Things Move

Imagine a ball lying on the ground, a closed door, and a bicycle leaning against a wall. All of these objects can move. What do you think causes an object to move? **Use** the text that follow to **investigate** **motion**. **Share** your ideas with your class.

A ball lying on the ground untouched does not move. When you kick it, your foot pushes the ball to make it roll. A closed door untouched also does not move. When you grab the handle and pull, the door swings open. Push and pull forces can sometimes be easy to observe.



Photo Credit: inigolai-Photography / Shutterstock.com

What about air? Can air provide enough **force** to move an object? Consider wind blowing through the leaves on a tree. Now picture a cart on the road. Could air, or wind, move a cart? The investigative engineers tested this question. Instead of waiting for the wind to blow, they strapped fire extinguishers onto a cart. As they release air from the extinguishers, the cart begins to roll. How fast and how far do you think the cart could move?

Talk Together Now, talk together about how the forces cause the objects to move?

Life Skills **I can ask questions to clarify.**

Activity 4

Observe Like a Scientist

What Do You Already Know About Starting and Stopping?

Share what you already know about starting and stopping by completing the following activities. After you have learned more, you can return to these activities to add to or change your responses.

How Do Objects Move?

Pushes and pulls move objects. **Write** one sentence that describes pushing something. **Write** a second sentence that describes pulling something.

Balanced and Unbalanced

Observe the image, which shows a rope being pulled in two directions. The rope is not moving in the image, but which way do you think it moved just after the image was taken? **Record** your prediction by drawing an arrow beneath the image. Then, turn to a partner and **discuss** your answers.



Children Playing Tug-of-War

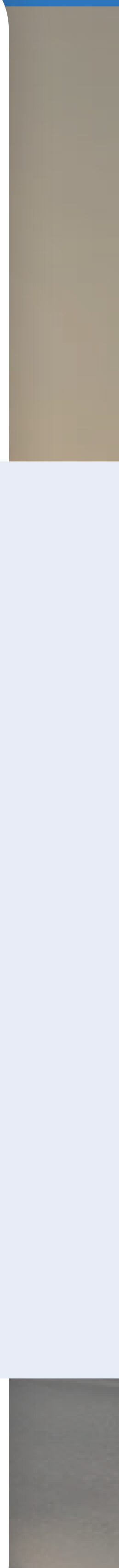
How Do We Know an Object Is Moving?

Activity 5

Analyze Like a Scientist

Objects in Motion

Read the text, then **answer** the questions that follow.



Objects in Motion

Think of a time when you played catch with a friend. The ball left your hands, travelled through the air, and then was caught by your friend. The ball landed in a different place from where it started, because it moved.

An object is in motion if it is moving from one place to another. When you look at an object, you can describe its position compared to other things around it. Imagine that you are standing next to a tree when you are playing catch. The starting position of the ball is close to the tree. When the ball travels through the air, it is in motion. It stops moving when your friend catches it. The ball's position changes, relative to the tree. Motion is any change in position relative to a fixed starting point.

What causes motion to start? For motion to start or stop, there must be a force, a push or a pull. When you threw the ball, you put it into motion using a push. **Gravity**, the force that pulls objects downward, caused the ball to drop into your friend's hand. The pushing force of your friend's hand against the ball stopped the ball's motion.

Some motion is easy to see, and some is not. It is easy to see a person walk down the street, a leaf blowing in the wind, or a ball traveling through the air after it is thrown. You know an object is in motion if you can measure changes in its position, even if you cannot see those changes. An object's change in position is compared to something else, usually something that is not moving.

What two things must occur for a ball to be in motion?

What are the two types of forces that can be used to put a ball into motion?

Life Skills **I can analyze a situation.**

What Makes Objects Move?



Activity 6

Observe Like a Scientist

Force

Two types of force put objects in motion: push and pull. Examples of these forces are around you everywhere you go. **Read** the text, if possible. **Look** for examples of pushes and pulls. Then, **answer** the questions that follow.

Every day, the world around us is in constant motion. Vendors push carts through busy markets, kids play football games, you travel to school and return home again. Some things move quickly, while others move slowly. All motion, fast or slow, is caused by force. Force is a push or pull on an object that causes it to change position.



Does force affect us when it feels like we are not in motion? If you are reading this, you are probably sitting in a chair. It may not feel like there is any force acting on your body. In fact, gravity is pulling you downward and holding you in the chair.

When you finish your work, you might push the chair away from your desk and pull your bag up from the floor. Did you know that in these movements, multiple forces are acting from different directions? Gravity pulls your bag down while your arm lifts it up. A key part of understanding motion is to recognize balanced and unbalanced forces.

Have you ever played tug-of-war? Two teams hold opposite ends of a rope. The players pull the rope toward them. If each team is pulling the rope with equal force, the forces are balanced. Neither team moves forward. If one team pulls with greater force, then the forces are unbalanced and the rope moves.

What are some examples of starting or stopping motion with a push? ____________

What are some examples of starting or stopping motion with a pull? ____________

Think about a time that you used force. What would that activity be like if there was no push or pull involved? ____________

Life Skills **I can identify problems.**

What Makes Moving Objects stop?

Activity 7

Analyze Like a Scientist

Stopping Motion

Before you **read** the text, **look** at these words and phrases. **Think** about what the text will be about based on this list. Then, **answer** the question that follows.

- slow down
- moving objects
- friction
- force
- stop

Stopping Motion

Let's consider the effect of balanced and unbalanced forces in more detail. A book lying on a table is being pulled down by gravity and pushed up by the force the table exerts. When the forces on an object are balanced, the object does not move.



Car Crash

When the forces on an object are unbalanced, the object could start moving, move faster or slower, or change direction. If force causes motion, how does an object in motion STOP?

Moving objects only stop when a force of the same size is applied to them in the opposite direction from which they are moving. Sometimes it is easy to observe where the force that stops an object comes from. If a car crashes into a wall, it may stop. The wall applied a force to the car.

Life Skills **I can use information to solve a problem.**



But why does that same car roll slowly to a stop if it runs out of gas on a level road? In this case, the car is being slowed down by a force called **friction**. You have probably heard of **friction**. Friction is a force that is exerted when objects rub against each other. Friction is a force that opposes motion. In the case of the car, this includes when its tires rub on the road and when air flows over the car and rubs against its surface.

When a car runs into a wall, make a claim about the size of the force of the car compared to the size of the force of the wall.

____

____

____

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Photo Credit: inigolai-Photography / Shutterstock.com

What Is the Relationship between Force and Energy?

Activity 8

Investigate Like a Scientist

Hands-On Investigation: Rolling Cars

Now that you know more about the causes of motion, in this activity you will explore the effect of applying different amounts of force to an object. You will investigate this by rolling toy cars across the floor. First, use what you already know to **predict** how far the toy car or truck will roll. **Complete** the activity, **record** your data, and then **answer** questions about what you observed.

Make a Prediction

Write your claim here.

What materials do you need? (per group)

- Toy trucks, cars
- Measuring tape

What Will You Do?

1. Gather your toy cars and trucks.
2. Plan a way to measure the distance your cars will travel, and create a simple sketch of your plan.
3. Push a toy car hard from a starting point.
4. Record the distance the toy car rolls.
5. Repeat steps 3 and 4 several times, and find the average.
6. Predict what will happen if you push your toy car very gently.



7. Push a toy car very gently from the starting point you used in step 3.
8. Record the distance the toy car rolls.

Record your data in the table.

Trial	Type of Push	Distance
1	Hard	
2	Hard	
3	Hard	
4	Hard	
Average hard push distance		
5	Gentle	
6	Gentle	
7	Gentle	
8	Gentle	
Average gentle push distance		

Think About the Activity

Think about the data you collected. How does this data support or go against your hypothesis? **Describe** how you know. Then, **answer** the question.

My Claim ______________________________

My claim is true because ______________________________

Could the distance each car traveled have changed if you had used a different car or truck?

____

Talk Together What do you think caused the car to start and stop moving? What is your evidence? How does the car compare to the airplane you saw in Wonder?

Activity 9

Observe Like a Scientist

Energy, Work, and Force

You already know that in order for motion to start or stop, force must be applied to an object. Now, you will explore the relationships between force, **energy**, and **work**. **Read** the text to find out how these three terms are connected. Then, **answer** the questions that follow.

To make a vehicle start or stop moving requires a force—either a push or a pull. Applying this force to the vehicle requires **energy**. Imagine you had to push a car along a flat road. Moving a car needs a lot of force. Soon you would be sweating hard as your body used up its energy reserves working to get the car moving.



Force and energy are different, but they are related to one another. Force is something that changes energy in such a way that it can do **work**. In the case of your pushing the car, the force your body exerts on the car is changing the energy in your body to energy in the moving car. When you move the car, you are doing work. To put it another way, a force transfers energy from one object to another. Work is the energy transferred by a force that is used to move the object.

Talk Together Now, talk together about the nature of force, work, and energy. What examples have you encountered during class?

Life Skills **I can respect others.**

Activity 10

Record Evidence Like a Scientist

Truck versus Airplane



Photo Credit: inigolai-Photography / Shutterstock.com

Now that you have learned about the role of balanced and unbalanced forces in starting and stopping motion, **review** the text, Truck versus Airplane again. You first saw this in Wonder.

How can you describe forces now?

How is your explanation different from before?

Look at the Can You Explain? question. You first read this question at the beginning of the lesson.

Can You Explain?

How do forces act on a starting and stopping object?

Now, you will use your new ideas about forces to answer this question.
To plan your scientific explanation, first **write** your claim.

Choose a question. you can choose a question “can you explain?” any question you have .

you can choose a question you wrote down in the begining of the lesson

My question



To plan your scientific explanation, first write you claim

My claim:

Next, **review** your notes and answers from throughout the concept. **Identify** two pieces of evidence that support your claim:

Evidence 1

Evidence 2

Now, **write** your scientific explanation.

The forces acting on a truck with jet engines cause it to start and stop because...

Life Skills **I can apply an idea in a new way.**

CONCEPT 2.2

Energy and Motion

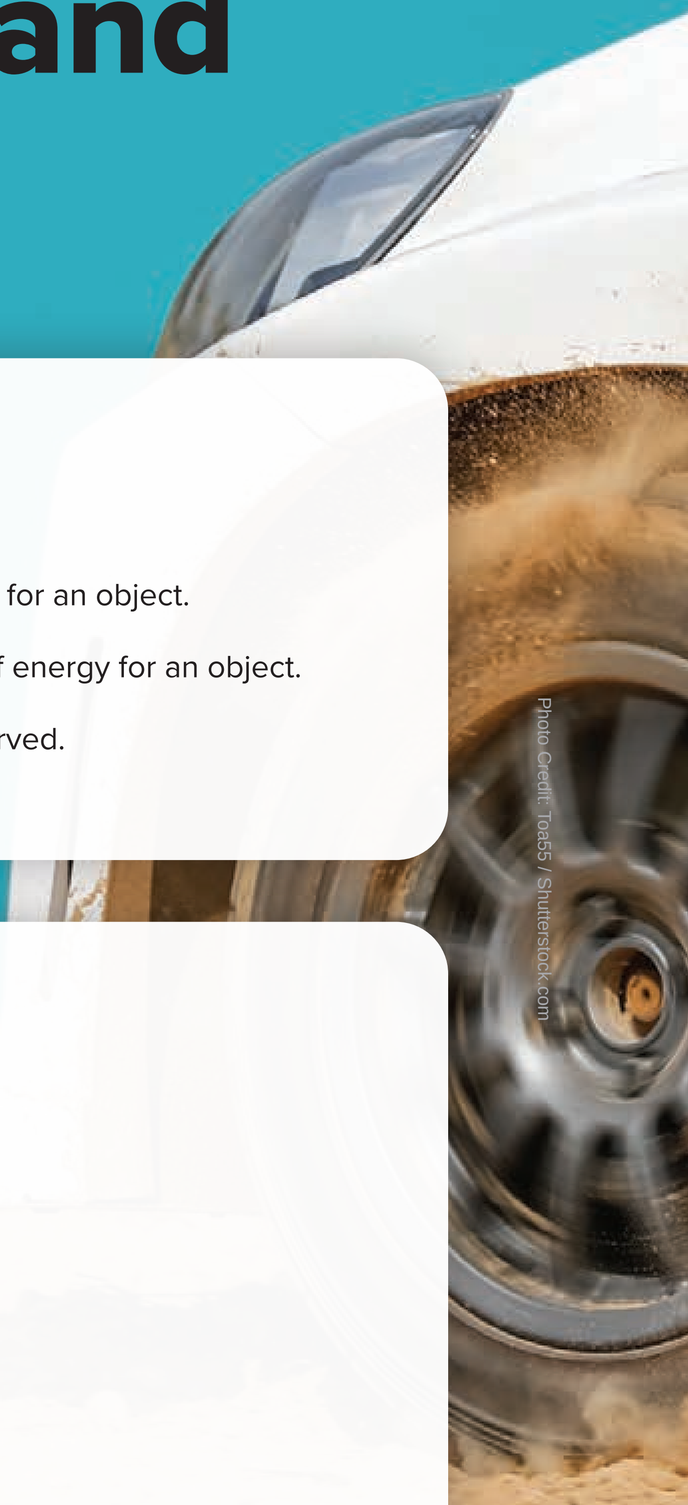


Photo Credit: Toa55 / Shutterstock.com

Student Objectives

By the end of this concept, I will be able to:

- ☐ Investigate the forms of energy in a system or for an object.
- ☐ Apply logical reasoning to predict the types of energy for an object.
- ☐ Cite evidence to explain how energy is conserved.

Key Vocabulary

- ☐ chemical energy
- ☐ gravitational potential energy
- ☐ kinetic energy
- ☐ potential energy
- ☐ thermal energy

Lesson 1

Activity 1

Can You Explain?



Have you ever seen someone running down a hill? What about a sand surfer on a dune? Were they moving fast or slow? How do you think moving objects, like a sand surfer, get their energy?

How do moving objects get energy?

____

____

____

____

____

Activity 2

Ask Questions Like a Scientist

Roller Coasters

Objects are moving around us all the time. A moving object has energy. Where do you think this energy comes from? Let’s investigate an example of an object that moves very fast: a roller coaster. **Read** the text. **Think** about what is needed to make a roller coaster move.

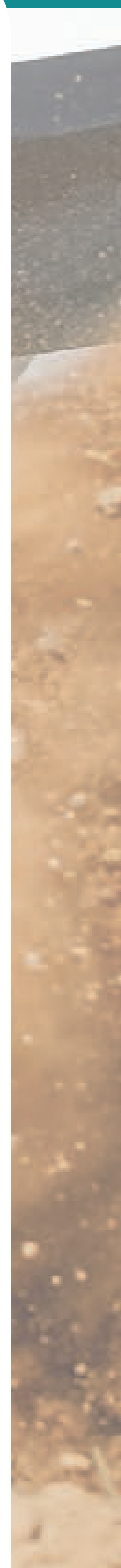
Have you ever been on a roller coaster? Imagine riding up a tall hill in a roller coaster car. You slowly creep up the first steep hill. You pause briefly at the top of the gigantic hill, holding your breath. Then the speed of the train you are riding will increase as it heads down the ramp.



So, where did the energy to go that fast come from? At the beginning of a roller coaster, electricity and motors are used to carry the car up to the top of the hill. But on the way down, the roller coaster car does not need electricity. The car actually stored up some energy just by traveling higher and higher. On the way down, this stored energy changed to a more active form of energy. In fact, as the roller coaster races down the hill, its energy increases the faster it goes.

What do you wonder about the energy needed to get the roller coaster moving? What happened to that energy as it moved? **Write** three questions you have about roller coasters and energy. **Share** your questions with a partner.

I wonder . . .



Activity 3

Evaluate Like a Scientist

What Do You Already Know About Energy and Motion?

Defining Energy

You have been thinking a lot about energy. Using what you already know, **write** your own definition of *energy*. Include an example to support your answer.

Moving Energy

Observe the pictures below and **think** about whether the ball has energy in each picture. **Circle** the images where you think the ball has energy.









Life Skills **I can share ideas I am not yet sure about.**

Activity 4

Observe Like a Scientist

Energy Basics

Energy is part of everything that happens in the world and everything we do. What is energy and how do we know we are using energy? **Read** the text. **Find** evidence to explain how energy and work are related.



Do you like to play outside, read a book, or draw? All these activities need energy. Energy is the ability to do work, or make things happen. Energy can be stored and changed into different forms. We cannot see energy, but we can see and measure what energy can do. Whenever you detect motion, heat, light, or sound, you can be sure energy is being used. Work occurs when a force causes an object to move. When you kick a ball, the force of your kick causes the ball to move in a different direction. Energy was needed to move your leg, which caused the ball to move.

Talk Together Now, talk together about the ways work and energy are related.

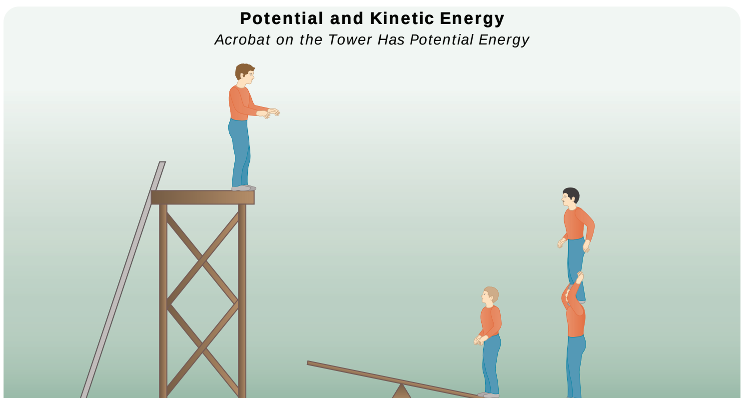
What Is Energy?

Activity 5

Analyze Like a Scientist

Kinetic and Potential Energy

Have you ever dropped a book on your foot? One way that scientists talk about energy is to classify energy as kinetic or potential. Objects have **kinetic energy** if they are in motion. **Potential energy** is possible, or stored, energy. While you hold the book, it has potential energy. When you let go and it falls on your foot, the book is moving and has kinetic energy. **Look** at the image. **Think** about what would happen next. Then, **read** the text and **write** your answer to the question.



Potential Energy in Acrobats

Kinetic and Potential Energy

Energy is the ability to do work. Energy makes things happen. If there were no energy on Earth, nothing would get done. There are two categories of energy: kinetic energy and potential energy. Kinetic energy is the energy of motion. The word *kinetic* means that something is moving. In other words, kinetic energy is the energy an object has because it is moving. Potential energy is stored energy or the position energy. Position in other words, potential energy means that an object is ready to do work or to be active.

What most likely happened next in the picture of the four acrobats?

Life Skills **I can identify problems.**

What Are the Different Forms of Potential and Kinetic Energy?

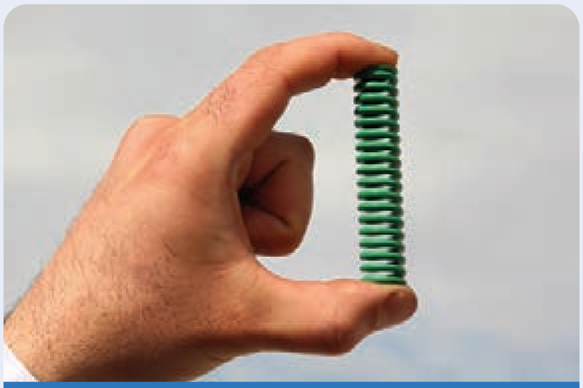
Activity 6

Analyze Like a Scientist

Forms of Potential and Kinetic Energy

What happens when you turn on a light? Energy can be stored in many different forms. Energy can also change from one form to another form. **Read** the text that follows. Use what you learn to **answer** the questions.

Forms of Potential and Kinetic Energy


Spring

Potential energy is energy that is stored in an object. You could say that an object with potential energy is not doing anything right now, but it has the "potential" to do work in the future. You have already learned about several types of potential energy. For example, a ball at the top of a hill has a type of potential energy, called **gravitational potential energy**, because it could roll down the hill. Batteries have potential energy in the form of stored **chemical energy** that is not used until the battery is connected to something. A compressed spring has potential energy that could suddenly be released if you are not careful.

Kinetic energy is the movement of something. When you ride in a car, the car's motion is kinetic energy. Sometimes it is not so obvious that something is moving. Kinetic energy also exists in:

- Sound or light waves moving through the air
- Movement of electricity though a wire
- Vibrations of particles in a substance as it heats up

This means that sound, electrical energy, and **thermal energy** are all types of kinetic energy.

Energy is transformed easily from one form into another. For example, a child at the top of a playground slide has potential energy. As the child moves down the slide, the potential energy is changed into kinetic energy. A car has potential energy when parked on a ramp and kinetic energy when it is moving down a ramp.

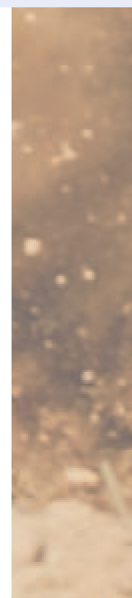
The following table contains examples of potential energy and kinetic energy.

Forms of Potential and Kinetic Energy, *continued*

Anything can have potential energy. How much potential energy an object has depends on a few things, including how massive the object is and how high up it is.

Can you think of a time when energy was changed from one form to another? A fan uses electrical energy that changes, or transforms, into kinetic energy when the blades of the fan move.

Potential Energy	Kinetic Energy
• Chemical • Gravitational	• Solar • Thermal • Electrical • Light • Sound



A roller coaster gains potential energy in the cars as it drags them up the first hill. What form of potential energy is it creating?

___

When the roller coaster goes down the hill, what form of energy is the potential energy converted into?

___

If an egg drops from your hand, what force pulls it to the ground? What kind of energy does the egg have as it falls? Where did the egg get the energy to fall?

___

___

Activity 7

Observe Like a Scientist

Types of Energy

Let's explore more examples of potential energy, kinetic energy, and how energy can be transformed from one to the other. **Read** the text that follows and **identify** two examples of potential energy and how they change. Can you think of other everyday examples?



Energy is all around us and is constantly changing and transforming from one form to another. Energy can also be transferred. When you kick a ball, energy moves from your leg into the ball. No matter how it changes or moves, new energy cannot be created and existing energy cannot be destroyed.

All forms of energy are either potential or kinetic. Potential energy is energy waiting to happen. This is also called stored energy. Energy can be stored in many different forms. Kinetic energy is energy in motion. Potential energy can easily transform into kinetic and kinetic can transform into potential.

Have you ever used a flashlight that required batteries? There is chemical energy stored in a battery. This is one type of potential energy. When the flashlight is turned on, the potential energy is transformed into radiant energy (light) and thermal energy (heat). A gas oven turns the chemical energy stored in natural gas into thermal energy that cooks your food. The food you eat also stores another type of chemical energy. Your digestive system breaks down the food you eat into energy it can store.

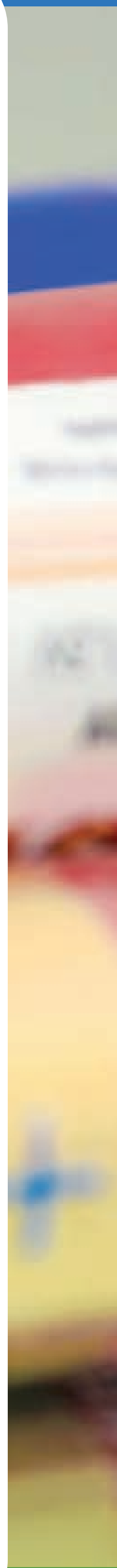
If you have ever used a spring-powered car, you might have noticed that its spring wire stores kinetic energy. When you let go, the spring wire unwinds and transforms into kinetic energy to make the car move. A real car transforms chemical energy into mechanical, sound, and thermal energy that are all kinetic as it drives down the road. The engine is where this transformation takes place, but can you guess what the source of the potential energy is in this example?

Discuss with your partner the enrgy transformation when the spring is compressed and then released

Complete the following table

	Examples	The energy converts from ...	The energy converts to ...
1	Kick the ball		
2	flash light		
3	A gas oven		
4	The food to eat		
5	A car works with fuel		

Talk Together In pairs, discuss two examples of potential energy being converted into kinetic energy from the passage. Identify the types of energy involved. Then, share a new example of this transformation from your daily life.



Activity 8

Evaluate Like a Scientist

Easy Life Tool

You have learned a lot about different forms of energy and how they can transform from one form into another. Now it is your turn to consider how this knowledge could help you design a simple machine. **Think** about the different forms of potential energy that make objects move. **Write** a list of tasks that would be easier to do with a tool. **Choose** one task and **design** a tool that would make this job easier to do, with less work for you. **Draw** your tool in action. **Use** arrows to show how the energy flows.

Life Skills **I can decide on a solution to use.**

Activity 9

Record Evidence Like a Scientist

Roller Coasters



Now that you have learned about energy and motion. You first saw this in Wonder.

How can you describe the motion of a roller coaster now?

How is your explanation different from before?

Look at the Can You Explain? question. You first read this question at the beginning of the lesson.

Can You Explain?

How do moving objects get energy?

Now, you will use your new ideas about energy and motion to write a scientific explanation that answers the Can You Explain? question. To plan your scientific explanation, first **write** your claim:

My claim:

Next, **identify** two pieces of evidence that support your claim. **Record** your evidence in the first column. Finally, **explain** your reasoning. Reasoning ties together the claim and the evidence. Reasoning shows how or why the data count as evidence to support the claim.

CONCEPT 2.3

Energy and Collisions

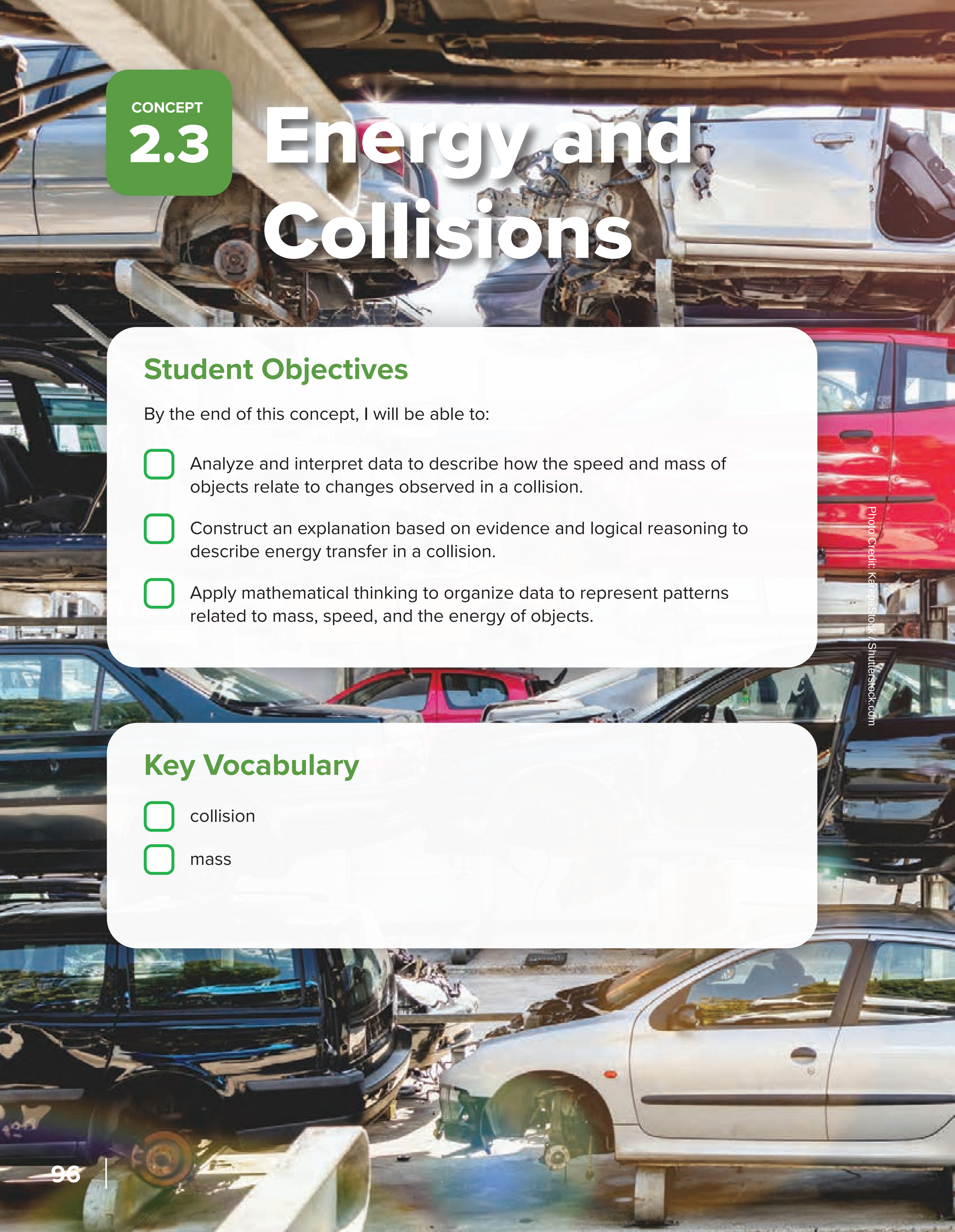


Photo Credit: KarepaStock / Shutterstock.com

Student Objectives

By the end of this concept, I will be able to:

- [ ] Analyze and interpret data to describe how the speed and mass of objects relate to changes observed in a collision.
- [ ] Construct an explanation based on evidence and logical reasoning to describe energy transfer in a collision.
- [ ] Apply mathematical thinking to organize data to represent patterns related to mass, speed, and the energy of objects.

Key Vocabulary

- [ ] collision
- [ ] mass

Activity 1

Can You Explain?



Have you ever seen a wrecking ball knocking down a building? A wrecking ball is usually a very heavy steel ball that swings on a cable. It helps construction workers knock down walls or parts of buildings. What other objects have you observed that collide or crash together?

What happens to objects when they collide with another object?

____

____

____

____

____

Life Skills **I can share ideas I am not yet sure about.**

Photo Credit: (a) KarepaStock / Shutterstock.com, (b) Inked Pixels / Shutterstock.com

Activity 2

Ask Questions Like a Scientist

Collision

Have you ever hit a ball with a bat or a stick? Imagine you are watching a cricket match. Cricket might be an unfamiliar sport to you. It is a popular game all over the world. In cricket, a player uses a wooden bat to hit a ball. The cricket player stands with a bat and moves it as the ball approaches at high **speed**. The bat makes contact with the ball.



Discuss with Your Class

Imagine that you are watching a player hit a ball with a bat. What happens to the energy from the moving bat to the moving ball? What do your senses observe? What would the player feel? What do you hear? What do you see?

After your discussion, **record** your answers.

Life Skills **I can analyze a situation.**

Activity 3

Observe Like a Scientist

Watching Objects Collide

Have you ever made toy cars crash into each other? Think about happened when they crashed. What safety equipment keeps us safe in our cars? **Read** the text, **write** three questions you have, and **share** them with the class.



What happens to your body when you ride in a car and the car stops suddenly? Your body continues to move forward. Objects that are in motion stay in motion until something stops them. When the car stops suddenly, what keeps you in your place? Seatbelts are used in cars to keep your body from moving forward. Seatbelts have saved thousands of lives.

Airbags slow the speed of a person moving forward. An airbag is like a big pillow to land against during a crash. Airbags inflate automatically when sensors in the car detect a crash. The purpose of an airbag is to absorb the energy of the car's impact. Airbags are made of thin, nylon material folded into the steering wheel, seat, dashboard, or door. A sensor tells the airbag to inflate. The airbag fills with a gas to provide a soft cushion. An airbag has to deflate almost as fast as it inflates. Airbags have holes, or vents, to allow the bag to deflate so you can get out of the car.

Every year, there are many accidents in which a train hits a car that may be stuck on the train tracks. Trains are much larger than cars. Trains can travel at a high speed. The higher the force when objects collide, the more dangerous it is. Could airbags on the front of a train help protect people in a car?

Life Skills **I can identify problems.**



be stuck on the train tracks. Trains are much larger than cars. Trains can travel at a high speed. The higher the force when objects collide, the more dangerous it is. Could airbags on the front of a train help protect people in a car?

I wonder . . .

I wonder . . .

I wonder . . .

Photo Credit: Vinicius Bacarin / Shutterstock.com

Activity 4

Analyze Like a Scientist

Basics of Speed

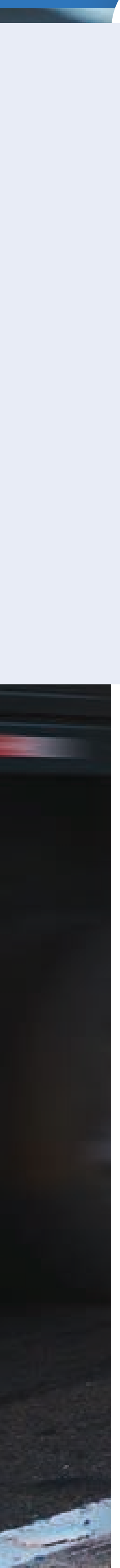
Think of a time when you were moving very quickly. Maybe you were riding in a car on the highway. Have you ever been stuck in a traffic jam? If you have, you remember that your car was moving very slowly. Objects move at different speeds around us all the time. **Read** the text and **look** at the image to learn more about speed. Then, **write** and **draw** your definition of speed.

Basics of Speed

Speed is a measurement of how fast something is moving. Speed measures the distance that an object travels over time. The speed of an object is the same no matter which direction it moves. If you move 5 meters backward every second or 5 meters forward, your speed is still 5 meters per second. Speed is displayed in units of distance over time. Therefore, to calculate an object's speed, divide the distance it travels by the time it takes to travel there. Some common units of speed are meters per second (m/sec) and kilometers per hour (km/hr or kph).



Traffic Sign



Basics of Speed, *continued*

To compare the speed of one object to the speed of a second object, measure the distance both objects travel in a given period of time. The object that travels the greater distance in the same amount of time is moving at a greater speed. If one runner travels 6 kilometers in 1 hour and a second runner travels 9 kilometers in 1 hour, the second runner is moving at a greater speed.

Another way to compare speed is to see which object moves a given distance in the smaller amount of time. Imagine two cars racing 1,000 meters. The car that finishes in less time is faster. It has the greater speed.

Speed is defined as distance per unit of time. We often see speed in units of kilometers per hour. Consider a car that travels 90 kilometers per hour. This car is faster than a car that travels 60 kilometers per hour.

Speed is . . .

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Photo Credit: Vinicius Bacarin / Shutterstock.com

What Is the Relationship between Speed and Kinetic Energy?

Activity 5

Investigate Like a Scientist

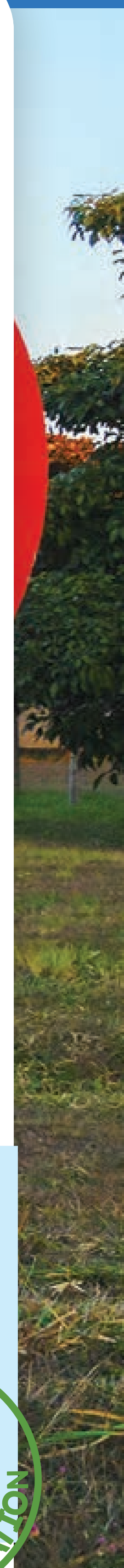
Hands-On Investigation: Racing Downhill

Consider what you have learned about speed and energy so far. In your last investigation, you changed the size of the ball that you rolled down a ramp. In this investigation, you will use model trucks to measure the speed and kinetic energy of objects moving down a cardboard tube at various angles, or inclines. You will measure the distance a paper cup moves when your truck rolls down the tube at each angle and into the cup.

Make a Prediction

How do you think kinetic energy will change with the angle of the tube?

How will the cup measure kinetic energy?



What materials do you need? (per group)

- Toy trucks
- Cardboard paper towel tube
- Paper cup, 360 mL
- Scissors
- Several books
- Metric ruler
- Removable sticky note flags
- Stopwatch

HANDS-ON INVESTIGATION

Life Skills **I can work to meet expectations.**

What Will You Do?

1. With your partner, record the number of books used to set up your tube in the column Number of Books.
2. Roll your truck down the tube, use the stopwatch to keep time, and record how long the truck takes to travel to the end of the tube in the column Time to Travel.
3. Add a book to change the incline angle and repeat the steps. Add a second book and repeat the steps again.
4. Now, repeat each incline, but place a cup at the bottom of the tube.
5. Measure the distance the cup moves after each time the truck rolls into it.

Number of Books	Time to Travel	Distance the Cup Traveled

Think About the Activity

What happened to the speed of the truck when the incline increased?

How did the results of the speed test compare to the results of the kinetic energy test?

What conclusion can you draw about the relationship between speed and kinetic energy, based on this experiment?

What do we observe when objects collide?

Activity 6

Analyze Like a Scientist

Energy and Collisions

Think of all the objects you bump into every day, such as walking into your friend in the hallway or hitting your toe on the leg of a chair. Ouch! Consider what happens to your body and the other person or object when these accidents happen. **Think** about what you already know about energy transfer. **Read** the text. Then, **complete** the activity.

Energy and Collisions



Children Running

When two things bump, or crash, into each other, we can say a **collision** has taken place. When this happens, an energy transfer occurs. Think about this: If you are running down the street without looking, and you run into a sign, what happens? The chances are you will stop moving, perhaps bounce off, and get hurt. The sign may wobble a bit and rattle. When you hit the sign, you would stop moving forward. What happened to your kinetic energy? What energy changes were taking place here? How would things be different if you were walking? What could have happened if you were running faster?

How does the speed of an object affect what happens in a collision

Activity 7

Analyze Like a Scientist

The Effect of Speed on Collisions

Remember when you rolled toy cars down a ramp? You learned that the speed of the car affected how far the cup moved when the car crashed into it. As you read, **highlight** information in the text that supports the patterns you saw in your data from the investigation Racing Downhill.

The Effect of Speed on Collisions

The amount of kinetic energy an object has depends upon its speed. The faster an object travels, the more energy it has. When a speeding object hits another object, it transfers some of its energy to it. The faster the object, the more energy it transfers. Some of this energy may be in the form of heat, light, or sound. Because of their extra energy, fast-moving objects can do much more damage than slow ones. When they hit an object, they exert more force. This force can smash a car fender or, in some cases, damage the car beyond repair.



Accident

Photo Credit: Rob Wilson / Shutterstock.com

If a car increases its speed, its kinetic energy increases. All this energy will result in a large force being exerted in an accident. This is one reason why driving fast is so hazardous. If two cars drive headlong into one another, then the forces exerted in the accident depend upon the combined speed of both cars. Damage would be much more severe. What do you think would happen if two cars traveling at different speeds in the same direction collided? How would the forces in this rear-end collision compare to those in a headlong collision?

Activity 8

Investigate Like a Scientist

Hands-On Investigation: Speed and Collisions

Now that you have reviewed your data from Racing Downhill, you know that objects traveling at a faster rate of speed have more kinetic energy. Now let's look a little closer at how force can affect both speed and kinetic energy. In this investigation, you will use a clay ball and a cardboard platform to investigate the speed and kinetic energy of objects.

Make a Prediction

How do you think the amount of force will affect the kinetic energy of an object?

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How are speed and kinetic energy related?

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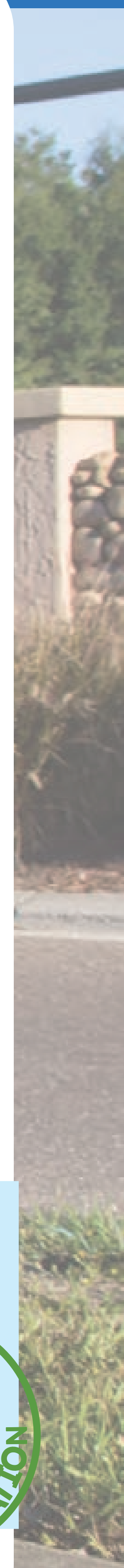
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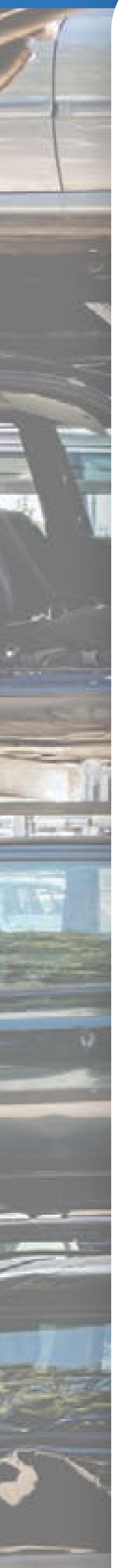
What materials do you need? (per group)

- Modeling clay or flour mixture
- Piece of cardboard
- Meterstick

HANDS-ON INVESTIGATION

Life Skills **I can think about how my team works together.**





What Will You Do?

1. Roll a ball of clay in your hands, smoothing the sides of it. Sketch the ball of clay.
2. Use the cardboard to create a landing platform, attached to a hard surface on the ground. Position the clay ball 1 meter above the platform and lightly open your fingers to drop, not throw, the ball of clay onto the platform.
3. Sketch the dropped ball of clay in the table.
4. Smooth the clay ball over and repeat the experiment, this time putting force behind the clay ball and throwing it at the platform from 1 meter above. Sketch the result.
5. Repeat one more time and throw the clay ball a bit harder at the platform. Sketch the result.

Amount of Force Used	Sketch of Clay
Dropped	
Thrown Lightly	
Thrown Hard	

Think About the Activity

What can you conclude about the relationship between speed and kinetic energy based on this experiment?

____

How do the results from this experiment compare with the results from the tests you did in Racing Downhill? How are they different?

____

What does the damage to the clay tell you about what happens to vehicles in a real-world collision?

____

Activity 9

Analyze Like a Scientist

The Effect of Mass on Collisions

The amount of **mass** in the objects involved in a collision can also make a big difference in the outcome of the crash. **Look** at the image of the trucks. **Think** about which vehicle would probably cause more damage in a collision. **Read** the text, and then **choose** two conversation starters to help you **discuss** your ideas with classmates.

The Effect of Mass on Collisions

Why do big trucks need bigger engines than cars? The difference has to do with the mass of each vehicle. A large truck has a much greater mass than a car. As each vehicle moves faster, the energy from the fuel its engine uses is converted into kinetic energy.

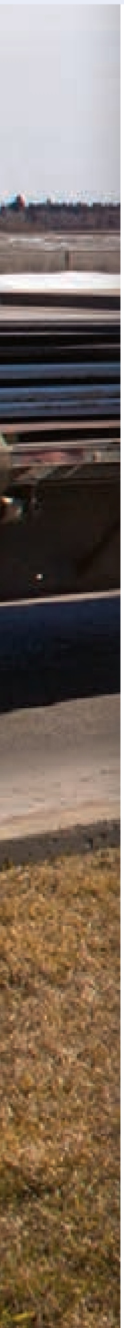


Comparing Trucks

The bigger the mass of the vehicle, the more fuel it consumes, and the more kinetic energy it gains. A large truck traveling at the same speed as a car has more kinetic energy. If the mass of an object doubles, its kinetic energy at a certain speed also doubles. So, a 1-ton truck has half the kinetic energy of a 2-ton truck traveling at the same speed.

The Effect of Mass on Collisions, *continued*

This is why a large-mass vehicle causes more damage when it hits something than a small-mass vehicle traveling at the same speed. If a pedestrian hit by a bicycle with a speed of 50 kilometers per hour, he will most likely survive, and if a car hits him at that speed, it may endanger his life.



Now, **choose** two of the conversation starters from the table.
Discuss what you have read.

Question	Clarify	Connect
I don't get this part . . .	Let me explain . . .	This reminds me of . . .
What if . . .	No, I think it means . . .	The differences are . . .
Predict	**Comment**	**Explain**
I wonder if . . .	This is confusing because . . .	The basic idea is . . .
I think that . . .	This is hard because . . .	My understanding is . . .

Lesson 4

Does Energy Disappear in a Collision?

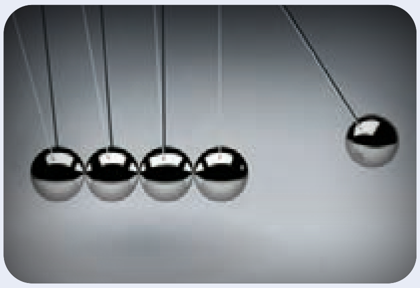
Activity 10

Analyze Like a Scientist

Energy Conversions during a Collision

You already know that when two objects collide there is a transfer of energy. When you play a game with marbles, kinetic energy is transferred from your arm to the marble. Then, there is a transfer of energy from your marble to the ones you hit to knock out of the triangle. Click! That sound you hear when the marbles collide is energy, too. Where did this sound energy come from? **Read** the text about Newton's cradle. As you read, **highlight** all the forms of energy to which kinetic energy is transformed.

Energy Conversions during a Collision



From what you have observed, you know that when objects collide, energy changes and transfers take place. The amount of energy depends on the kinetic energy of the objects and the direction in which they are traveling. Their kinetic energy is determined by both their speed and their mass. What happens to all this kinetic energy when objects collide?

None of the energy disappears. In a collision, energy in equals energy out. Energy is conserved in a collision. We can model collisions using a simple device called a Newton's cradle. In a Newton's cradle, most of the energy is transferred to other balls, which is why the same number of balls move on one side of the cradle as on the other.

You can hear that some energy is lost as sound. Some is lost as friction between the string and other parts, as the balls move. The balls lose a little energy as they pass through the air. If you leave the cradle long enough, after lots of collisions, the moving balls lose their kinetic energy and stop.

Talk Together If a moving car hits a stop sign, not all the energy transfers to the stop sign. Where else does the energy go?

Solve Problems Like a Scientist

Unit Project: Vehicle Safety

Car makers design vehicles for safety. But how do they know what happens to cars during different types of crashes? Is it possible to design cars that are safe in all types of crashes?

Common safety features on cars include seat belts, air bags, headrests, and ways to maintain safety. Carmakers are always looking for new ways to keep drivers and passengers safe. New technologies can help. Carmakers study the effects of crashes to design these new technologies.



Car Crash

When you travel in a car and it suddenly stops, the forward force of the car's motion continues to act on the passengers. A car crash using a mannequin where it looks as if the person is flying forward. Most of the time, a seatbelt is used to hold the person in place so that they do not hit the steering wheel, dashboard or front windshield of the car. Sometimes, however, a seatbelt is not enough to protect the passengers. Airbags have been added to many cars in both the front of the vehicle as well as in the side doors to help protect people inside during a collision or a sudden stop. These airbags are folded up inside the framing of the car and are activated by a sudden change in direction or motion, or by the impact of a collision or crash. Airbags are designed to cushion the passengers so that they do not hit any of the hard objects inside the car or fly forward outside of the vehicle.



Life Skills **I can use information to solve a problem.**

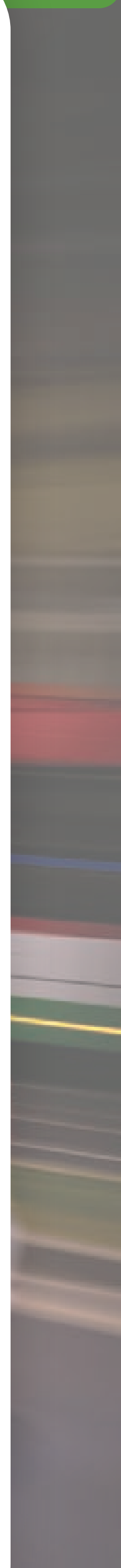
Car Crash Safety

You have learned about airbags and how they keep people safe. Now, conduct research online about the latest safety features carmakers are using to protect drivers and passengers. Choose one new safety feature other than airbags introduced in the last 10 years and create a plan to improve this device.

You will be creating a report or presentation to share with your teacher and your class. Your report should describe how the impact of a collision will trigger the device to activate and which riders in the car would benefit from its protection. You should include your design, the methods you plan to use to test your device, and any modifications you would make to improve your device using technology or other innovations.

Include in your report the types of crashes the device best protects against, the direction of the forces involved in these crashes, and the ways the feature counteracts them. Also, discuss at least one way this safety feature could be improved.

Notes



Assess your learning

Choose the correct answer from the following:

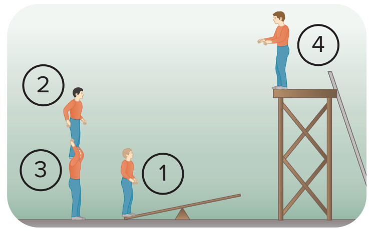
1. In the opposite figure:

   The body is under the effect of:



   A - Balanced forces and moving to the right.
   B- Balanced forces and moving to the left.
   C- Unbalanced forces and moving to the right.
   D - Unbalanced forces and moving to the left.

2. In the opposite figure:



   In which one the player has the greatest potential energy?

   A- player (1) B- player (2).
   C - player (3). D- player (4).

3. The energy gained by a ball when it falls from above is:

   A - Potential energy. B - Kinetic energy.
   C – Light energy. D - Chemical energy.

4. If the angle of inclination of a surface increases, so the speed of the rolling body....

   A- decreases B- increases
   C- not affected D- equals zero

5. When a collision occurs, the sum of the energies before the collision is .... the sum of the energies after the collision:

   A - equal to. B – less than
   C - more than. D - not equal

6. When the moving car stops suddenly, the passenger's body moves to the .... direction.

   A - right B - left
   C – forward D – back.

7. The airbag helps to ....

   A- Reduce the speed of a person's movement forward.
   B- Increase the speed of a person's movement forward.
   C - Reduce the speed of a person's movement backwards.
   D - Increase the speed of the person's movement backwards.

Answer the following questions:



1. In the picture in front of you:
   (a) Are the forces on both sides balanced or unbalanced?.................................
   (b) In which direction will the children move? (Right or left)

2. If the two cars moved at the same time for 20 seconds, car (A) covered a distance of 100 meters, while car (B) covered a distance of 300 meters.

   Which of the two cars has a higher speed?



3. In the opposite figure:

   When the compressed spring is released, a change in energy occurs. From ....energy to .... Energy.

4. Look to the car in the picture in front of you, then complete:
   (a) The type of energy with which it operates.
   (b) This car is characterized by a ....weight.

Photo Credit: KarepaStock / Shutterstock.com

Match column (B) with column (A):

(A)
1- Gravity
2- friction
3- speed
4- Potential Energy

(B)
a) the energy stored inside the body
b) the force that pulls things downwards
c) A force that arises between the surfaces of two contacted bodies.
d) Energy stored inside dry batteries
e) The distance covered per time unit.

Safety in the Science Classroom

Following common safety practices is the first rule of any laboratory or field scientific investigation.

Dress for Safety

One of the most important steps in conducting a safe investigation is dressing appropriately.

- Use gloves to protect your hands and safety goggles to protect your eyes when handling chemicals, liquids, or organisms.
- Wear proper clothing and clothing protection. Tie back long hair, roll up long sleeves, and if they are available, wear a lab coat or apron over your clothes. Always wear close-toed shoes. During field investigations, wear long pants and long sleeves.

Be Prepared for Accidents

Even if you are practicing safe behavior during an investigation, accidents can happen. Learn the emergency equipment location if available and how to use it.

Most importantly, when an accident occurs, immediately alert your teacher and classmates. Do not try to keep the accident a secret or respond to it by yourself. Your teacher and classmates can help you.

Practice Safe Behavior

There are many ways to stay safe during a scientific investigation. You should always use safe and appropriate behavior before, during, and after your investigation.



Safety Goggles

- Read all of the steps of the procedure before beginning your investigation. Make sure you understand all the steps. Ask your teacher for help if you do not understand any part of the procedure.
- Gather all your materials and keep your workstation neat and organized. Label any chemicals you are using.
- During the investigation, be sure to follow the steps of the procedure exactly. Use only directions and materials that have been approved by your teacher.
- Eating and drinking are not allowed during an investigation. If asked to observe the odor of a substance, do so using the correct procedure known as wafting, in which you cup your hand over the container holding the substance and gently wave enough air toward your face to make sense of the smell.
- When performing investigations, stay focused on the steps of the procedure and your behavior during the investigation. During investigations, there are many materials and equipment that can cause injuries.
- Treat animals and plants with respect during an investigation.
- After the investigation is over, appropriately dispose of or store any materials that you have used. Ask your teacher if you are unsure of how to dispose of anything.
- Make sure that you have returned any extra materials and pieces of equipment to the correct storage space.
- Leave your workstation clean and neat. Wash your hands thoroughly.